ELECTRICAL ENGINEERING

JANUARY 1959
Vol. 78, No. 1

75 Years — A Prologue to the Future

THE COVER: Symbolizing the six AIEE Divisions—Communications, General Applications, Industry, Instrumentation, Power, and Science and Electronics—the design on this month's cover shows the widespread coverage of each. Remo Cosentino, member of the AIEE editorial staff, is the artist.

Contents

A Salute to the American Institute of Electrical Engineers
Dwight D. Eisenhower, President of the United States 1

Engineering Progress—1958

Reviewed by AIEE Technical Committees
A review of noteworthy developments in the field of electrical engineering during 1958 by the Institute Committees 2

Engineering Developments, 1958
Pictorial report showing some of the many outstanding electrical engineering achievements of the past 12 months 4

Utilization of Engineering Talent *H. R. Huntley*
One of the most important problems which industry must solve is that of utilizing engineering talent effectively 42

City-Wide Personal Signaling at Allentown–Bethlehem, Pa. *C. R. Kraus*
Features of Personal Signaling Service, new telephone communications development, include pocket-carried receivers and selective signaling system 49

Variation of the Trip Point in the ORNL Type Safety System *J. L. Cockrell, C. W. Ricker*
Interactions accompanying the interconnection of safety amplifiers in nuclear reactor control instrumentation are discussed 54

Flicker Effects of Single-Phase and 3-Phase Motors Compared *Bryce Brady*
Basic concepts on the merits of single vs 3-phase motor for residential uses may have to be altered in view of new knowledge on the subject 58

Gyromagnetic Ratio of Proton Redetermined *R. L. Driscoll, P. L. Bender*
Accurate redetermination of this constant makes possible more accurate values for all physical constants whose values depend on magnetic measurements 65

The Application of Shift Register Techniques to Materials Handling *H. C. Diener, Jr.*
A description of the versatility of shift registers as a building block for control of industrial materials handling systems 69

A New Approach to Training Telephone Engineers *W. C. Burnett, L. C. Adams*
Clemson College and Southern Bell Telephone Co. have developed a new technical training method for experienced telephone engineers 75

CONTENTS CONTINUED

Published monthly by American Institute of Electrical Engineers

ELECTRICAL ENGINEERING: © Copyright 1958 by the American Institute of Electrical Engineers; printed in the United States of America; indexed annually by the AIEE, weekly and annually by *Engineering Index*, and monthly by *Industrial Arts Index*; abstracted monthly by *Science Abstracts* (London). Address changes must be received at AIEE headquarters, 33 West 39th Street, New York 18, N.Y., by the first of the month to be effective with the succeeding issue. Copies undelivered because of incorrect address cannot be replaced without charge.

The "EVP" Test Contributes to the Efficiency and Reliability of Paper Cables

V. L. Garrison
Plant Manager

The efficiency and reliability of a paper cable is dependent to a large extent upon how thoroughly the paper insulation has been oil-impregnated. Oil-inhibiting "wet spots" should be completely eliminated and the overall moisture content of the insulation brought down to a predetermined minimum. Only then is the cable ready for impregnation. For maximum assurance, the cable should be moisture-tested to determine when the optimum amount of moisture has been taken out of the insulation.

A power factor or capacitance test is used by most manufacturers to determine when the cable has been dried long enough. This is a simple expedient but has the disadvantage of being inaccurate after the bulk of the moisture has been extracted from the insulation. The only way to be absolutely sure the cable has been adequately dried is to measure the moisture itself. For this purpose, Okonite Research adopted the Equilibrium Vapor Pressure Test ("EVP" for short). This unique test indicates precisely when a paper cable is ready to be oil-impregnated.

How dry is "dry"?

A "Junior Refinery" Assures Low Power Factor in Okonite Paper Insulation

. . . as pure as pure can be

Impregnating paper insulation with electrically-unqualified, impure oil can cause a cable to be inefficient . . . to have a high power factor. For this reason, even the highest quality impregnating oils must be "refined" to bring them up to the strict Okonite requirements. At Okonite, all oil submitted by our suppliers is first checked for its electrical properties and then processed through our "junior refinery" for purification. This involves treating the oil with a cleansing agent, degasifying it, and subjecting it to several filterings. Throughout the purification cycle the oil does not come in contact with the air. This prevents contamination.

1. A test for directly determining the dryness of paper insulation before it is impregnated with oil, and

2. a "junior refinery" to insure that only fully qualified oil is used . . .

. . . two concrete examples of the effort that Okonite exerts to insure that the paper cables we make for you are the best it is possible to produce. Thi all evidence to the fact that Oko paper cables contain *added val* values that are not written into spe cations.

Today, every good engineer I kno looking for ways to get the maxim value out of the money he invests his company or client. The *a values* in Okonite paper cables pro an opportunity to get extra life dependability out of electrical c systems. As one engineer to anoth urge you to become better acquai with the long range economy Okonite paper cables.

If you have not received your cop the new paper cable catalog, or if I be of help to you with a current p lem, please get in touch with m The Okonite Company, Passaic, N

where the electr po

. . . . there's OKONITE CA

Contents Continued

Technical Paper Digests

Tramp-Iron Remover for Forage Harvester	*F. C. Jacob, J. B. Dobie*	48
Power Transformer with an IBM 650	*L. J. MacKinnon*	53
The "ON/R" System	*G. T. Masters*	64
Water Cooling of Turbine-Generator Stator Windings	*G. V. Browning, C. H. Holley, J. F. Quinlan*	68
Frequency Transient Measurements in Power Systems	*G. N. Swanstrom*	74

Departments

Electrical Engineering Education	75
AIEE in Iowa State College	75
Television Receiver Designed for Classroom Use	78
An Electrical Engineer in Industry	79
ECPD Bibliography of Electrical Engineering Subjects	80
U-M Reports on Demand for Engineering Graduates	81
Hydroelectric Dam and Generator Kit for Schools	82
Institute Activities	84
Largest Technical Program Scheduled for 1959 AIEE Winter General Meeting	84
United Engineering Trustees, Inc., Annual Report for the Year 1957-58	88
Schedule of AIEE General and District Meetings	89
Schedule of Special Technical Conferences	89
AIEE Future Meetings	90
Progress Toward the New United Engineering Center	93
Papers Which Were Planned for the AIEE Fall General Meeting	94
Attractive Emplaqued Membership Certifications Available to All Grades	99
Sample Contents Lists from USSR Scientific and Engineering Journals	100
AIEE Fellows Elected	105
AIEE Personalities	107
Obituaries	108
Of Current Interest	109
3000-Kw Gross Heat Produced by Portabe Direct-Cycle Boiling Water Reactor	109
Electrostatic Recording Device Prints 3,000 Wpm a Line at a Time	111
Future Meetings of Other Societies	111
IGY and Space Flight Information	113
Protons Guided by Magnets in Synchrotron	116
United Nations Information Available	116
Distribution of Radioisotope Standards	117
Components Readied for Belgian Power Reactor	117
X-ray Image Intensification System	118
Instrument Traces Record of Solar Radiation	119
Medical Electronics International Organization	119
Electroluminescence from Barium Titanate	120
New Books	120
Technical Literature	122
Annual Index to Electrical Engineering, 1958	1–20
New Products	18A
Industrial Notes	30A
Trade Literature	38A

Statements and opinions given in articles appearing in *ELECTRICAL ENGINEERING* are expressions of contributors, for which the Institute assumes no responsibility. Correspondence is invited on controversial matters. Published monthly by the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
Founded 1884

Headquarters, 10th floor • Editorial Offices, 6th floor
33 West 39th Street, New York 18, N. Y.

L. F. HICKERNELL, President — N. S. HIBSHMAN, Secretary

PUBLICATIONS DEPARTMENT: L. R. Gary, *Chairman* H. N. Muller, Jr., *Vice-Chairman* C. S. Rich, *Secretary*
E. W. Boehne, D. T. Braymer, C. E. Dean, L. K. Del Homme, W. F. Denkhaus, E. I. Gross, E. T. B. Gross, W. R. Harris, W. Scott Hill, C. W. Leiby, F. C. Roberts, J. D. Tebo

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office Hildreth Press, Bristol, Conn. Editorial and advertising offices 33 West 39th Street, New York 18, N. Y. Member subscription $6 per year nondeductible from dues; single copy 75 cents. Nonmember subscription $12 per year plus extra postage to all countries to which second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Bristol, Conn., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538. P. L. & R. Act of February 28, 1925. January 1959. Vol. 78, No. 1. Number of copies this issue, 65,000.

Charles S. Rich
Editor and Manager of Publications

G. C. Baxter Rowe
Associate Editor

Editorial Assistants
A. M. Fallert
E. Jacobs
J. S. Lusterman
V. S. Tavitian
S. Walters
R. E. Whitlock

Advertising
J. S. Lopes
Central Manager and New York

J. S. Holzer
Eastern Manager and New York

A. E. Del Gado
Mid-West Manager
1604 Chicago Ave., Evanston, Ill.
Tel: Greenleaf 5-7321

T. P. Galavan
A. O. Dillenbeck, Jr.
West Coast Adv. Office
266 South Alexandria Ave.
Los Angeles 4, Calif.
Tel.: DUnkirk 5-3991

Waldo Schraubstader
Market Research Director

M. R. Rodgers
Advertising Production Manager

ABC
Member
Audit Bureau of Circulations

REVOLUTIONARY NEW POWER SWITCH

featuring... VACUUM!

The success or failure of any power switch depends on the strength and all-around efficiency of its dielectric. Over 17 years of research and development by Jennings Radio Manufacturing Corporation plus hundreds of installations in the power field prove that a vacuum has no rival as an interrupting medium. Here are the reasons:

A vacuum dielectric is 30 times stronger than air. In fact, contact openings of only 1/32 inch will hold off over 100,000 volts because practically no molecules remain to be ionized.

A vacuum dielectric is also characterized by extremely rapid recovery in dielectric strength because the vaporized contact material which carries the current diffuses very rapidly into the surrounding vacuum. Therefore, 60 cycle power circuits are always interrupted at the first current zero.

These facts have been recognized for years but now Jennings has developed unique processing methods that make a vacuum dielectric practical in power switches. These techniques insure a stable vacuum wherein contacts and vacuum seals will not break down even though subjected to enormous abuse over a long period of time.

Unusually long contact and vacuum life is assured by these cleaning and outgassing techniques. Low energy arcs reduce erosion of contacts and vacuum actually improves with repeated current interruption. This incredibly clean vacuum also permits the use of contacts made of refractory metals with high resistance to welding.

Vacuum switch installations for capacitor switching, line dropping, load break, and circuit breaker applications are now being made by switchgear manufacturers using Jennings' vacuum switch contacts. We have prepared literature describing the ten sizes now available for power use. Send for your copy.

Jennings RADIO MANUFACTURING CORP. • 970 McLaughlin Ave., P. O. Box 1278 • San Jose 8, Calif.

A Salute to the American Institute of Electrical Engineers

To the members of the American Institute of Electrical Engineers joined in the observance of their 75th Anniversary, I send greetings.

Over the past three-quarters of a century, you have contributed much to our national strength, prosperity and well-being. Through the work of your profession, I am sure you will continue to render a major service to our people.

Congratulations and best wishes,

Dwight D. Eisenhower

A I E E 75th Anniversary 1884 — 1959

75 Years—
A Prologue to the Future

ENGINEERING PROGRESS—1958

Reviewed by AIEE Technical Committees

THE YEAR 1958 was marked by widespread progress in electrical engineering, as reported by 32 of the Institute's technical committees in the six broad fields of activity covered.

In the field of communication, considerable work has been done both in random-noise and information theory. Further application of tropospheric scatter links has also been announced.

Achievements in the category of general applications include new lightweight commuter cars, increased use of computers for solving operational and design problems in land transportation and a co-operative research and development program for rapid transit. An outstanding development in electric appliances was the application of the Peltier effect to produce both heating and cooling in the same device.

Among developments in industry have been automation in warehousing and materials handling techniques, accurately controlled electric drive systems for textile mills, and automatic gage control for steel mills. Considerable progress also has been made in inertial guidance systems, an important factor in the success of missiles and space vehicles.

Advances in instrumentation have included application of new principles to the design of transducers, controllers, and recorders, as well as increased use of transistors and magnetic amplifier components in place of vacuum tubes. There has been a notable increase, too, in the application of electronic instruments to process control.

Progress in the power field during 1958 has been extensive. The size of steam-electric generating units has continued to increase, and greater attention has been given to the possibility of automatic operation of large generating units and the use of data-logging equipment. There has also been considerable activity in research for technical knowledge in extrahigh-voltage transmission. An important milestone in power generation was the dedication of the Shippingport Nuclear Power Reactor Plant in Pennsylvania.

In the field of science and electronics, achievements have included development of infrared detection devices for communication and tracking, new circuitry combining magnetic amplifier and controlled semiconductor devices, and significant advances in nucleonics.

Communication

COMMUNICATION THEORY

A NEW COMMUNICATION SYSTEM, called Rake, designed expressly to work against the combination of random multipath and additive noise disturbances, was reported during the past year. This system was the outgrowth of theoretical studies of the multipath communication problem.

There has been much interest in the properties of random noise. A number of papers on axis crossings appeared, and results were reported on envelope characteristics, output of nonlinear devices with noise inputs, and filtering. Several authors described new results on detection of signals in noise.

Interest continues in binary coding problems, with papers appearing on binary communication systems with feedback, a study of random codes using a digital computer, and work on Grey unit-distance codes. A new high-efficiency coding system with relatively simple decoding equipment has been discovered. Nonbinary codes were the subject of several papers, and results on digital filters were reported.

Interest in broader aspects of information theory is increasing, especially in the areas of self-regulating or learning machines, self-reproducing machines, or machines to do information-handling problems previously done only by humans. Two papers appeared on a problem new to information theory: computation in the presence of noise. Further results on picture coding and language translation have also been reported. In addition, important progress has been made on the mathematical foundations of communication theory.

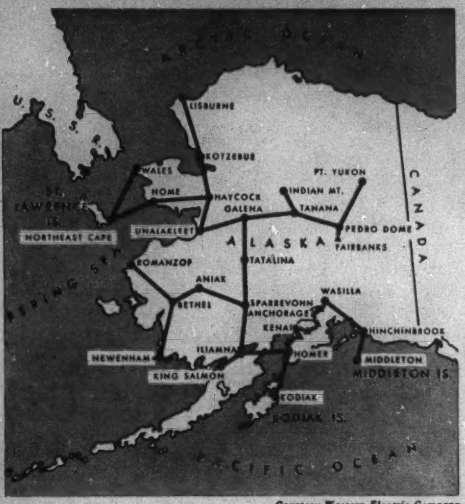
RADIO COMMUNICATION SYSTEMS

THE PAST YEAR has seen further application of tropospheric scatter links in military and civilian systems. The largest network to date employing this mode of radio propagation, the "White Alice" system of Alaska, was placed in service during March 1958. Other notable over-the-horizon (O/H) links were inaugurated between Mexico City and Acapulco, Mexico, and between Quebec and Labrador, Canada. Experiments indicate that useful tropospheric transmission can be obtained on frequencies up to 8,000 mc or more at ranges of 200 miles.

Molecular or parametric amplifiers with very low inherent noise are being developed to extend the range of O/H links by permitting reception of weaker signals.

Systems of communication via the ionization resulting from meteor bursts have been placed in service in Canada. Possibilities of long-range communication by relays from passive or active earth satellites are being studied.

Many extensions were made during the year to the network of international connections which provide customer-to-customer teleprinter service via radio circuits equipped with automatic error correcting apparatus.



Courtesy Western Electric Company

Route of Alaska's "White Alice" communications network. Black dots and lines represent stations and routes of beyond-horizon radio, for spanning distances up to 170 miles on this network. Black triangles and broken lines represent stations and routes of microwave radio relay, used over short distances in inaccessible areas.

Public air–ground telephone service is being tested. Trials have been made in several cities of personal signaling service superimposed on the common-carrier public mobile radio service.

Personal paging receivers have been reduced by use of transistors to a size of 1 by 3 by 6 inches, including battery and antenna. Some of these units will respond to a single selective call out of 10,000 possible combinations. Others have built-in horns producing audible output 50 feet from the receiver.

The first commercial links of the type *TJ* multichannel microwave relay system operating in the 11,000-mc band were placed in service between Pocatello and Idaho Falls, Idaho, and between Los Angeles and Compton, Calif.

Other microwave systems operating in the 2,000-, 4,000-, and 6,000-mc bands have been installed during the year in many industrial, Government, and common-carrier communication networks in the United States and Canada.

Improvements have been made in klystron and traveling wave tubes and in the reliability of equipment using these tubes in the frequency ranges from 450 to 12,000 mc.

AST-101 air transportable transhorizon system, developed by the Collins Radio Company.

TELEGRAPH SYSTEMS

DURING 1958 there were numerous developments in telegraph systems and apparatus in a variety of fields, including switching and selective calling systems, carrier and ocean cable telegraphy, facsimile, and printing telegraph apparatus.

The recently developed MITE teleprinter is a remarkably lightweight, compact page teleprinter which uses many innovations new to the teleprinter art. A complete send–receive unit weighs approximately 12 pounds, yet is capable of operating at a speed of 100 words per minute. Another new page printer, Airborne Teletypewriter *AN/AGC-1*, was developed for the U.S. Air Force. It incorporates a magnetic recorder–reproducer device for information storage and a selective call system. Electronic techniques are used to reduce the mechanical components to a minimum.

The first automatic teleprinter exchange in the United States was installed in New York City. This exchange is connected to the Canadian Telex network. Any subscriber in the system can automatically establish a point-to-point teleprinter circuit to any other subscriber by dialing the called subscriber's number on a conventional telephone dial plate.

TELEVISION AND AURAL BROADCASTING SYSTEMS

THE INCREASING IMPORTANCE of radio is reflected by the unabated upswing in licenses granted by the Federal Communications Commission (FCC). The Commission has more than 2.1 million radio authorizations on its books. Of these, 1.5 million are commercial radio operator permits required to man this country's spreading forest of transmitters. Authorizations for radio stations exceed 450,000 with broadcast stations above 9,000. Of this number, 874 are television stations, 791 FM, and 3,353 AM.

FCC approval of remotely controlled transmitters for both high-power (50 kw) and directional antennas opens a new field of operation. Experimental work in automatic logging should enable further modernization of the technical operation of radio stations. Work in compatible single sideband is going on to determine practical obtainable results. Widespread increase in use of miniature components and equipment and remote pickup equipment makes the engineer even more important to the broadcast station.

(Continued on page 28)

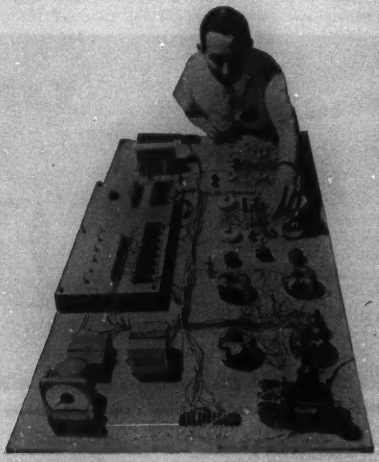
1958

Engineering Developments

Launching of the USS Triton, August, 1958 at Groton, Conn. Courtesy General Dynamics Corporation's Electric Boat Division.

A Photographic Record of Some of the Important Electrical Engineering Achievements of the Year.

Courtesy General Electric Company

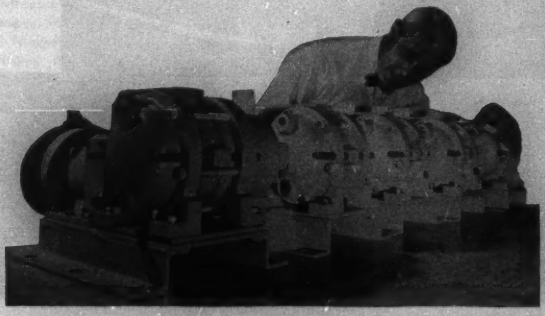


Courtesy General Dynamics Corporation's Electric Boat Division

▲ The operator (at console in foreground) puts the Universal Submarine Simulator into a dive for the benefit of Navy trainees learning how to "take 'er down" in the tradition of the submarine service. The simulator will give submariners at the New London Submarine Base intensive land training never before available. The instructor-diving officer (at center in the "sub"), grades each trainee's ability while an electronic "report card" in the console records the trainee's reactions.

◀ This all-electric feedwater valve developed by General Electric's Instrument Department controls the flow of water from the turbine generator to the steam generator in the nuclear submarine, *USS Triton*. It can be operated automatically or manually to maintain the correct water level over a wide range of operating conditions.

▼ Looking more like electric motors than instruments, these differential pressure detectors will sense the flow of steam and water from the steam generator to the turbine in the feedwater loop of the *Triton*'s instrumentation system. Signals from the detectors, developed by GE, go to a three-element magnetic computer, which controls the position of the feedwater valve.



◀ (*Facing page, left*) View of a dual element resistance temperature detector for taking critical temperature readings in the nuclear reactor compartment of the atomic submarine, *USS Triton*. Readings are recorded in a fraction of a second of temperature changes within an accuracy of one-seventh of one per cent over a range of zero to 700 F. (*Facing page, right*) L. C. Noyes, GE project engineer, adjusts circuitry of newly developed magnetic amplifier laid out on "breadboard." Magnetic cores (doughnut-shaped objects) replace all vacuum tubes in instrumentation system of *USS Triton*.

RESEARCH

Courtesy MIT

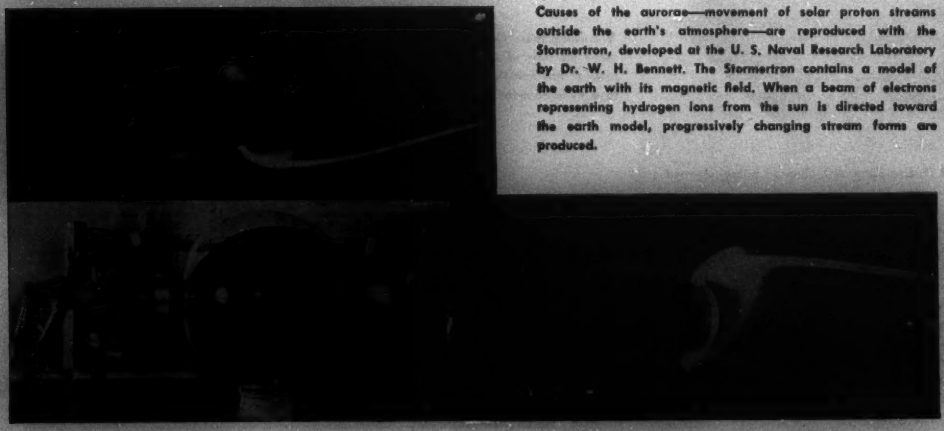
▲ Dr. G. N. Hatsopoules (*left*) and Dr. Joseph Kaye of the department of mechanical engineering at the Massachusetts Institute of Technology hold model of a device they have invented for converting heat directly into electricity. Called a thermoelectron engine, the model operates without mechanical moving parts and may become practical for many purposes, including more effective use of atomic energy in small power plants.

ITT Laboratories Photo

▲ William Sichak, director of radio communications at ITT Laboratories, Nutley, N. J., examines the newly developed "low-noise" or parametric amplifier for over-the-horizon microwave radio links. Heart of the amplifier is a minute silicon diode, perched atop a "penny platform" in the foreground. According to Mr. Sichak, the amplifier can add 100 miles to existing radio links or cut transmitter power requirements 90 per cent. The device can "turn up the volume" in a radio receiver without amplifying noises in the equipment itself.

Official Photograph, U. S. Navy

◀ A capacitor bank with 15-million-ampere short-circuit current capability is giving added impetus to experiments by A. C. Kolb on high-velocity shock waves in thermonuclear devices at U. S. Naval Research Laboratories. The 99 capacitors shown, totaling 1,430 μf, store 285,000 joules at 20 kv, and create discharge currents of 7–10 million amperes into an external inductance of about 0.01 μh. Discharge currents are passed through a coil around the vertical section of a T-shaped tube down which a plasma shock wave is propagating. These currents produce fields which serve to insulate the shock wave from the tube walls.



Causes of the aurorae—movement of solar proton streams outside the earth's atmosphere—are reproduced with the Stormertron, developed at the U. S. Naval Research Laboratory by Dr. W. H. Bennett. The Stormertron contains a model of the earth with its magnetic field. When a beam of electrons representing hydrogen ions from the sun is directed toward the earth model, progressively changing stream forms are produced.

◀ Final inspection of the air accelerator for a unique supersonic wind tunnel is made at the Groton, Conn., plant of General Dynamics Corporation's Electric Boat Division. The wind tunnel will put ramjet engines through test flights up to 2,500 mph. Air can be accelerated from standstill to full speed in 7 seconds and wind direction can be changed by up to 30 degrees to simulate exact conditions of an engine in flight from takeoff to landing. (*Right*) The gyromagnetic ratio of the proton (a measure of its interaction with magnetic fields) has been redetermined by the National Bureau of Standards with greater accuracy. The solenoids (center) causes protons in water sample to precess with an accurately measureable frequency. Ratio is calculated from precession frequency and the field strength.

▲ Advance studies of sound and vibration in conjunction with building atomic submarines are being conducted in this unique reverberation chamber at General Dynamics Corporation's Electric Boat Division. Here a noise analysis is being made on scale model of submarine hull, mounted on seismic block to neutralize earth's vibrations. Information gained is being used to establish submarine designs that will be quieter while affording maximum underwater operating efficiency.

▲ Electrodynamometer used in the National Bureau of Standards' re-evaluation of the standard ampere. It has been shown that the standard ampere maintained by the Bureau has drifted no more than a few parts per million in the last 15 years.

◀ Model examines the amount of infrared waves absorbed by a chemical mixture before the information is used in an electronic spectroanalyzer. ITT Laboratories, Nutley, N. J., a division of International Telephone and Telegraph Corp., is developing the instrument to speed the identification of body hormones for the Sloan-Kettering Institute for Cancer Research. (*Right*) This new National Bureau of Standards r-f power standard is a dry static calorimeter type which serves as a transfer standard between accurately known values of d-c power and the r-f power to be measured. It has a dynamic range from 20 milliwatts to 12 watts and a frequency range from d-c to 300 mc. Error is held to a maximum uncertainty of 0.5% in measuring r-f power.

NUCLEAR REACTORS

▲ Seen through a set of cooling coils, a canned motor-pump with its own wrapping of coils is made ready for Belgium's first atomic power plant. Two of these pumps, each rated at 300 hp, are among the components being constructed by Westinghouse for the Belgian power reactor. These units will circulate water at 6,250 gpm through the primary loop of the reactor to extract its heat.

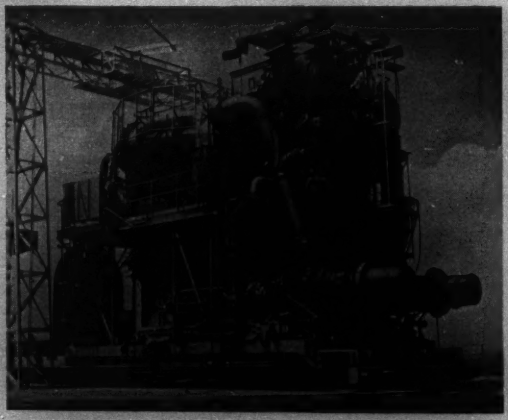
Courtesy General Electric Co.

▲ Construction of the Commonwealth Edison Dresden nuclear power station, largest all-nuclear station being constructed in the United States, is about 6 months ahead of schedule. The 180,000 kw plant is shown under construction, with the 190-foot steel sphere housing for the reactor and the huge turbine–generator building complete.

► First high-temperature nuclear test reactor ever constructed will be used to confirm design data for reactor cores of submarine *USS Triton*, launched August 1958. GE project engineer examines container for plate-type fuel elements in reactor, first such assembly to permit study of core configurations at zero power and still duplicate actual pressurized water power reactor operating conditions.

▲ General Electric model of a boiling water reactor propulsion system for merchant ships is checked over before shipment to Conference on Peaceful Uses of Atomic Energy held at Geneva, Switzerland last year. The GE Atomic Power Equipment Department (APED) recently announced that this type system has important advantages over other reactor types for marine propulsion service. It also has distinct advantages over conventional propulsion systems. The reactor is in cutaway sphere at right with remainder of propulsion equipment to the left of the reactor.

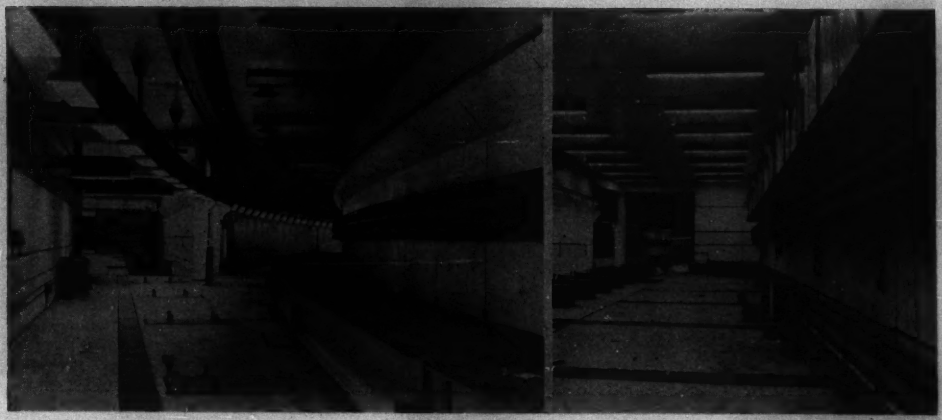
► View of equipment the GE Aircraft Nuclear Propulsion Department (ANPD) used to conduct the first known successful ground operation of aircraft jet engines powered by a nuclear reactor. It was also on display last year at Geneva. The large tank contains an air-cooled, water-moderated reactor. Air is compressed in the two GE modified *J-47* engines (*right*) and piped to the reactor where it is heated. The heated air then turns the *J-47* turbine rotors and passes out the end of the engine nozzles at extreme right to provide propulsive power.



▲ Installing the 750,000 electron volt Cockroft-Walton set in AGS Linac building. This machine will provide initial acceleration to protons; then they are injected in 50 million electron volt linear accelerator before entering AGS orbit for acceleration by 12 r-f stations to their ultimate energy of 25 billion electron volts.

▲ Some of the 240 magnet sections for Brookhaven National Laboratory's Alternating Gradient Synchrotron (AGS), assembled in the target building for testing, before installation in the ½-mile circular tunnel. The force created by the magnets keeps the accelerating protons on course during the 1-second period of energy buildup, which is provided by 12 r-f amplifiers. Each time the protons pass an r-f station, they receive an additional 1,000 electron volts of energy. Thus, at the end of 1 second, they have circled the magnet ring about 350,000 times, and have attained a velocity of over 186,000 miles per second.

◀ In the left foreground is the AGS complex, with the magnet tunnel buried beneath a 10-foot circular dike of earth. In the center are the reactor and hot laboratory buildings, and to the right is part of the main laboratory complex. In the right foreground are the cosmotron and nuclear engineering buildings.



▲ Inside circular tunnel. At right are a few of the pedestals upon which the 240 magnet sections will be installed. On the left is the Linac building showing foundations where the linear accelerator will be installed. (*Above right*) View from the Linac building, where the protons will receive their initial acceleration by a linear accelerator before they are injected into the AGS orbit.

Communications

▲ View of an experimental transistorized automatic dialer under study at the Bell Telephone Laboratories. A list of some 50 frequently called telephone numbers is preset into the instrument. Pushing a single button dials number from list.

Courtesy General Electric Company

▲ GE's newly introduced, two-way portable radio features new techniques in transisterization and miniaturization. To make servicing easy, the unit includes a hinge feature, which makes more surface available to technicians for maintenance purposes. Also, a feature of the set is plug-in transistors which may easily be removed for service checking. The device incorporates the first tubeless receiver to be used in vhf mobile communications services. Sensitivity of the equipment (0.4 microvolts) will be important in remote areas.

◀ Western Union's new FM data channel permits the handling of IBM punched cards at a rate of 11 cards per minute and also provides a faster inquiry and answer service for computer interrogation systems such as are used for airline reservations. Keying rates up to 180 baud can be accepted and the accuracy and dependability necessary in data transmission have been emphasized in the design.

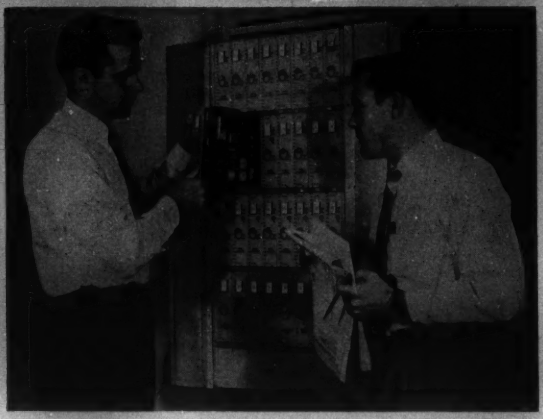
Courtesy General Dynamics, Stromberg-Carlson Division

▲ Transistorized field telephone designed and built for U. S. Army Signal Corps has compact waterproof case containing six ordinary flashlight batteries to provide all needed power. Buttons instead of dial give faster, more accurate signaling. Knobs adjust both incoming and outgoing volume, and select handset–headset operation.

◀ Fully automatic telegraph switching equipment, the Western Union Plan 55-A, is being installed for the U. S. Air Force for the operation of its new world-wide communication system.

Courtesy Bell Telephone Laboratories

▲ This experimental coin telephone is undergoing several months of public trial at Woodbridge, N. J. The gong and chime have been replaced by an electronically generated signal that gives one "beep" when a nickel is deposited, two for a dime, and five for a quarter.



▲ A 24 channel, pulse-code modulation terminal currently under test at Bell Laboratories. C. G. Davis (*left*) removes a channel unit from the frame as J. J. Shanley checks the circuit.

◀ Experimental electronic telephone instrument under development at Bell Telephone Laboratories. This trial model contains transistor circuits for both speech transmission and tone ringing, and uses pushbuttons instead of the usual dial. Pushbuttons send multifrequency tones in place of the usual direct current pulses to the central office.

Courtesy Western Union

▲ Flat-bed facsimile transmitter provides for magazine loading of messages to be transmitted. Up to 20 such pieces in sizes up to 8½ inches wide and legal document length can be handled successively without further attention.

▲ Western Union's Plan 37 Switching System provides for the automatic retransmission of messages originating on customer's printers directly into the nation-wide public message switching system. System automatically inserts customer and message identification, point of origin and transmission time and date information.

▲ Single column of 460-kv rating of GE air-blast breaker.

► This compact 138-kv telescoping switch, 7 feet in diameter, is the first to be enclosed within a section of isolated phase bus. Built for use in high-voltage metal-enclosed switching stations, the unit permits a significant saving in space. The switch has 3 insulators mounted in compression to provide strength to withstand any mechanical stresses created during short-circuit conditions.

Courtesy I-T-E Circuit Breaker Company

POWER

Westinghouse Photo

◄ This metal-clad breaker (150-DH-1000) was designed primarily to protect distribution circuits in large substations in metropolitan areas. The unit contains a 13.8-kv magnetic air circuit breaker of 100-mva interrupting capacity. Although it has 35% greater interrupting capacity than the next lower rating of its type, it has the same height and width and is only 4 inches deeper.

► View of the first compressed air circuit breaker rated at 7,000 amperes, 14.4 kv, and 2,500 mva. These breakers are the same physical size as a 5,000-ampere breaker.

Westinghouse Photo

Courtesy I-T-E Circuit Breaker Company

◄ Fast, low-cost reclosing protection for subtransmission and for higher voltage distribution lines is provided by new single-phase 34.5 and 46-kv automatic circuit reclosers. For the first time the new reclosers give power companies at subtransmission voltages the same economical service reliability available formerly only at lower distribution voltages.

► Metal-enclosed, power-class recloser switchgear, the first ever offered to the electric power industry, brings recloser advantages to urban or suburban substations where enclosed switchgear is specified. L-M's switchgear units can be applied on circuits rated 2.4 through 15 kv. Bus continuous current ratings are 800, 1,200, and 2,000 amperes. Impulse level is 110 kv. Recloser continuous load ratings range from 25 through 560 amperes.

Courtesy Line Material Industries

◀ A 30,000-square-foot two-pass condenser, largest ever shipped by Allis-Chalmers completely tubed, was supplied the Otter Tail Power Company's Hoot Lake Station in Fergus Falls, Minn., in 1958. Containing 5,460 tubes each 24 feet long, the condenser is serving a 53,500-kw reheat steam turbine–generator unit. Shell of the unit, shown here, is 24 feet long, 14 feet 8 inches wide, and 6 feet 8¼ inches high.

► Substation transformers lighter, smaller, and more efficient than previous models were developed by GE in 1958. Formex wire is used exclusively for turn insulation. Coils are rectangular, instead of round, reducing size. Small panel radiators further increase compactness, cutting floor space 29% and weight 32% below previous designs. New units are available in ratings up to 500 kva, 15 kv.

Westinghouse Photo

▲ Power transformers continued their phenomenal rise in rating, the record this year being chalked up by a 380-mva generator transformer delivered to Commonwealth Edison Company early in 1958. But more interesting than the size of its rating is that this unit provides greater capacity in less space than any other ever built. This transformer is lighter, lower, and narrower than similar units with only 80% as much capacity.

Westinghouse Photo

▲ First commercial transformer ever built using the new "inner-cooled" design is a 3-phase substation unit rated 30/40/50-mva, 115 kv. In these transformers, oil is circulated between strands of parallel conductors at the same potential; thus, oil ducts are eliminated between coils and windings.

Courtesy General Electric Co.

▲ What are believed to be the world's first a-c mine load centers with cast coil construction have been shipped to the Kaiser Steel Company's Koehler Mine in New Mexico. The 4 mine load centers are rated 300 kva each and suitable for most applications which previously required sealed dry-type transformer construction.

► A new self-regulating transformer has been designed to improve electric service and increase consumer satisfaction. Regulation is accomplished by automatically changing the transformation ratio in 2½% steps over a voltage range of 10%. Effective band width is 3½ volts centered around a base voltage of 120 volts. Concerning rated primary voltage, the regulation range of 10% can be manually selected to be from 90% to 100%, from 95% to 105%, or from 100% to 110%.

Courtesy Line Material Industries

Westinghouse Photo

▲ Glowing electroluminescent panels—man's newest source of light—glow with letters and figures in a new display system bright enough for use in broad daylight and no thicker than a sheet of ordinary glass. The display shows only the exact information desired without the need for dial watching for estimated readings.

▲ Federal Telephone and Radio Company, a division of ITT, has developed device *7D-2000*, an automatic programmable continuity test set which can be readily adapted to satisfy a wide variety of test requirements. Up to 258 wires of any multiple or single circuit configuration can be tested at the rate of two tests a second. For greater capacity, range extenders may be utilized, with each extender increasing the total capacity by 259 tests. Each wire is tested simultaneously for opens, shorts (to any other wire or to ground), transpositions, and continuity. Each of these 4 conditions creates a different indication on the device front panel meter.

Westinghouse Photo

► New applications of ultrasonics have been made possible by the development of a new and improved ultrasonic transducer. A radical new design has resulted in a device that is twice as efficient and considerably more compact than existing units of comparable power. To obtain a piston-like action of the transducer plate, the transducer eliminates entirely the idea of separate stacks of laminations scattered at intervals across the plate's surface. Instead, the laminations are spaced into a sort of latticework across the plate. Each lamination is attached individually to the plate; therefore, it is a driving element, working in unison with all the others.

▲ A chrome-plated electromechanical letter-sorting machine that is handling more than a quarter of a million pieces a day was placed in operation last year at the Washington (D.C.) Post Office. Built by a Belgian subsidiary of ITT, the semi-automatic machine permits each of 6 operators, sitting at keyboards, to sort 3,000 letters to 300 destinations every hour.

Westinghouse Photo

▲ This huge inductance coil supplies energy to an electric arc tunnel for testing missiles. It is similar to that used on a current-limiting reactor, except for the vast difference in size. It is wound with thirty-six 850-mcm cables in parallel.

LIGHTING

▲ Holophane's lightweight, 4-foot long prismalume (crystal acrylic plastic) Controlens (No. 6010) has prismatic design and concave shape providing exceptional control of fluorescent light, particularly for large areas. Reflected glare is minimized because of the uniform luminosity of the entire lighted Controlens surface.

Westinghouse Photo

▲ Packaged, transistorized power sources for fluorescent lighting systems can deliver any fixed frequency over the entire audio range. Standard 3-phase power is first rectified, then converted by transistor circuits. Output on oscilloscope is a 1,500-cycle sinusoidal wave peaking at 150 volts.

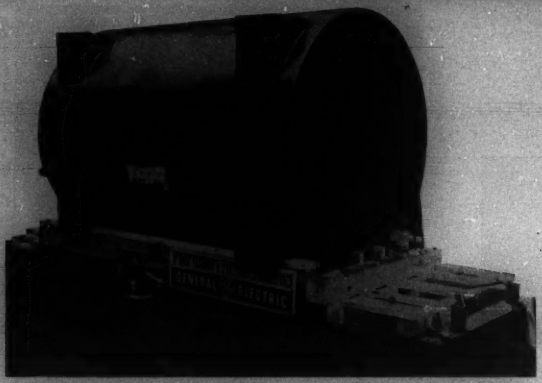
▲ Modern-styled outdoor luminaire (Holophane No. 440) utilizes one-piece prismatic, thermal shock resisting, glass refractor with streamlined weather-resistant fixture. The unit accommodates either a 500-watt incandescent lamp or a 400-watt mercury vapor lamp and provides wide light coverage allowing for spacing ratios of 6 or 8 to 1.

Westinghouse Photo

▲ A method of mechanically chopping a beam of light into "pieces" only a few billionths of a second in length produces sharply designed, ultrafast pulses of light which are used for testing speed of response of electronic devices to light and other radiations.

▲ Holophane's linear refractor (Prismalume No. 4800) utilizes the advantages of fluorescent lamps in mountings that parallel the lines of the street. It presents the ideal illumination results from continuous parallel row systems plus supreme glare control. It assures notable reductions in installation and operating costs. Luminaire is designed for relatively high footcandle level installation (1½ footcandles initial and above).

◄ Taking photometric readings of a street-lighting luminaire normally takes two technicians about 4 hours, or a total of 8 man-hours. Calculation of the light values and distribution, and plotting of curves takes another 25 to 35 hours. Now, using the automatic photometer developed by Westinghouse lighting engineers plus a digital computer, the readings can be taken and recorded by one man in an hour, and all calculations and curve plotting done in 13 minutes. The system automatically takes light readings at preselected points in the light beam. Programming of the photometer is accomplished by two tape readers. The present unit is designed for mercury and incandescent street-lighting units; engineers now are working on a similar arrangement for fluorescent units.



▲ Some 50,000 kw of additional electric power for the expanding industries around Haifa, Israel, will be available by mid-1959 when a new steam turbine–generator unit is placed in service by the Palestine Electric Power Co. at the Sukreir steam plant. Shipped from GE's Large Steam Turbine–Generator Department was this 125-ton generator stator, which is the heaviest portion of the power maker. This newest unit will boost the Sukreir station's capacity to 150,000 kw. GE also manufactured the two other units currently in service at Sukreir.

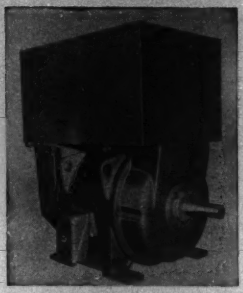
▲ 35-ton "bird-cage," over 26 feet long and with a diameter of about 10 feet, is actually the inner cage portion of an electric power producing generator made by GE.

▲ Biggest and most powerful steam turbine ever built in the West is this 156,250 kw machine. This is the first of five identical units being manufactured by Westinghouse for Japan. More than one million pounds of steam per hour will pour through the 3,600 rpm turbine. Steam will enter the turbine at 1,050 F, and a pressure of 2,400 pounds per square inch. Tips of the longest turbine blades in the spindle will travel at the rate of 1,070 miles an hour. When completed, the turbine shown will weigh 600,000 pounds, will be more than 15 feet high, nearly 20 feet wide and nearly 43 feet long. Over all length of turbine and generator will be nearly 85 feet.

Westinghouse Photo

▲ The longest motor-generator set ever built by Westinghouse has been shipped to the U. S. Steel Corporation's Gary Steel Works in Indiana. Rated at 13,500 kw, the equipment will be used to drive a 12,000-hp twin-drive mill motor and a 4,000-hp edger drive motor which will operate the slabbing mill at the Gary Works.

◀ Adjustable-speed drive incorporates a-c motor, a d-c motor, and semiconductor rectifiers within an integral unit. Known as Rectiflow drives, they afford continuously variable-speed control over speed ranges of 1½ to 1, 2 to 1, or 3 to 1; maximum speed is 1,690 rpm. All power requirements are supplied from normal a-c distribution systems.



▲ This unit in a new line of totally enclosed Allis-Chalmers motors has self-contained heat exchanger cooling for operation in highly contaminated atmospheres. Available in constant or adjustable speeds in frame sizes of EB-120 and up and in ratings from 10 through 200 hp, the motor's independent cooling system is unaffected by its speed.

▲ This special reluctance synchronous motor was developed by Robbins & Myers to drive magnetic tape reels used with electronic computers. When motor is turned on the entire rotor and shaft assembly moves axially to bring rubber-covered drive capstan into operating position. Axial movement of the shaft is controlled by a coil spring installed within the motor housing.

▲ Major changes in GE Form G fractional hp motors will enable reduction of assembly and maintenance costs in over 1,000 applications. Features include plug-in quick-connects for all terminals; quick change of rotation by simple reversal of the two plug-in motor leads; and brass links that simplify voltage change on dual-voltage motors.

▲ GE's KSP-51 frame vibrator motor for health devices. Completely enclosed, the 3½-inch diameter unit is available in single and adjustable speed drives.

▲ A 50-hp GE underwater motor is shown mounted in a ship's rudder to aid in low-speed steering. The motor is designed to run underwater with its windings, bearings and magnetic components totally immersed. A new insulation system using irradiated polyethylene was the major factor in development.

▲ All-synthetic insulation system for GE hermetic motors consists of acrylic resin magnet wire enamel, polyester film phase and ground insulation, and polyester fiber lead cable insulation, sleeving, and tying cord. Introduced early in 1958, the all-synthetic insulation system provides advantages long desired for air conditioning and refrigeration compressor applications.

Westinghouse Photo

▲ A new concept in the design of large a-c motors permits the enclosure to be manufactured independent of the wound stator. Now, during assembly, the enclosure is merely bolted to the base of the motor making the wound stator fully accessible when required. Previously, the enclosure was welded or cast as part of the wound stator, limiting accessibility.

MICROWAVES

▲ A traveling-wave tube which provides cw powers of 100 milliwatts or more at 55,000 mc with a bandwidth of 10,000 mc is in an early stage of development at Bell Telephone Laboratories. Interest in frequencies in this range has been sparked by the possibility of long distance transmission at millimeter wavelengths using a circular electric mode in round wave guide pipe buried in the ground. The tube described is intended for use as a power amplifier in such a communication system.

► M. Uenohara of Bell Telephone Laboratories is mounting a special diode in a waveguide structure for checking the amplifying properties of the diode. A pump frequency of 12,000 mc comes in from the left. The signal, in this case 6,000 mc, comes in from the right, is amplified and reflected back inside the same waveguide. The incoming and outgoing signals are separated by a ferrite microwave circulator.

Courtesy I-T-E Circuit Breaker Co.

▲ Largest waveguide rotary joint ever made was delivered to the U. S. Air Force for use in a prototype radar warning system. The aluminum joint, coupling antenna to transmitting source, will handle an unprecedented 80 megawatts of power with a voltage standing wave ratio of only 1.2 over a 10% bandwidth. Six feet high and four feet in diameter, the joint will sweep a huge search radar antenna at rates up to 40 rpm.

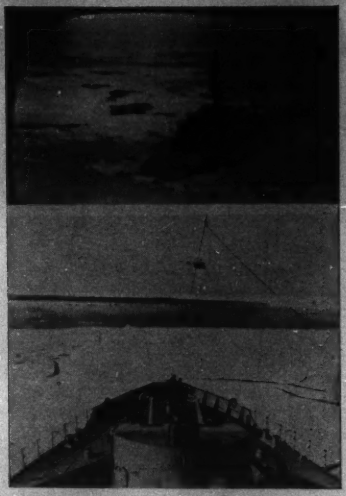
Courtesy Sierra Electronic Corp., subsidiary of Philco

▲ Electronic-telemetering system for measuring water content of snow in the High Sierra mountains directly affects the economy of the San Joaquin Valley agricultural area. Watertight box at left (base of tower), houses the vhf receiver and transmitter.

Courtesy I-T-E Circuit Breaker Co.

▲ U. S. Army's portable automatically telescoping antenna mast is 20 feet high and can be extended another 30 feet in 3 minutes by motor-driven compressor.

▲ A "3-dimensional" radar which detects airborne targets at extreme range and for the first time simultaneously computes distance, bearing, and altitude has been developed by Hughes Aircraft Company. Called Frescanar, the new radar is the eyes of "Missile Monitor," a U. S. Army air defense guided missile fire distribution system. Plastic balloon, resting on mobile trailer bed like a golf ball on a tee, forms housing for antenna which is protected from snow, ice, and wind.



▲ Picture of U. S. Navy icebreaker USS *Glacier* appears on television monitor aboard the *Glacier*, transmitted from observation helicopter via Philco airborne television system as the ship breaks through ice fields enroute to Thule AFB, Greenland.

◀ Two-camera Du Mont educational closed-circuit television package is shown in operation during chemistry laboratory lecture at a New Jersey college. Portable control station (*lower right*) has video monitor for each camera and line monitor (*extreme right*) showing exact picture being distributed by r-f to classrooms using similar standard receivers. Control panel controls switching and camera selection and remotely controls one camera for any of three lens changes, focusing, and moving the camera up or down and left or right.

▲ Remote controlled Philco industrial television camera (*left*) picks up the "battle picture" at isolated machine gun emplacement and relays scene to Pennsylvania National Guard troops (*right*) watching a frontal attack on a rifle company in defense. Action took place during recent field training at Indiantown Gap Military Reservation. The camera is small enough to fit into a brief case and the entire system weighs less than 70 pounds. It was the first time this type of equipment was used by a State National Guard unit.

COMPUTERS

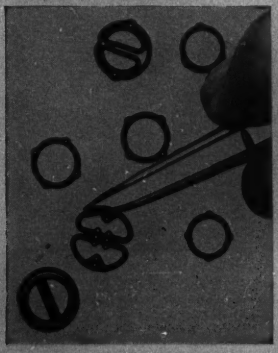
Sylvania Electric Products Inc.

▲ Mobidic, the U. S. Army Signal Corps' "brain of tomorrow," a mobile digital computer on wheels, is designed to fit into a standard, 28-foot trailer. The general-purpose electronic computer is designed to solve a large variety of military problems ranging from battle strategy and tactics to logistics.

▲ Philco and the Uptime Corporation have announced a joint program to develop and market a new high-speed punched card reader, the "Speed-reader 2000." It reads conventional punched cards row by row, 80 columns wide, at the rate of 2,000 cards per minute. It also has a capacity in the feed and stacking hoppers for 4,000 conventional punched cards.

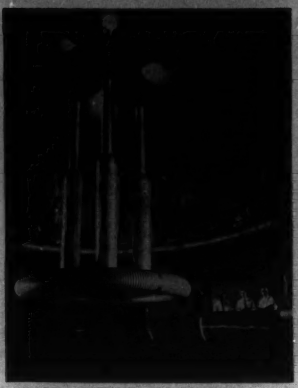
► IBM's Data Processing Division has a marketing program specifically designed to bring office mechanization to smaller business. Under the plan, a new low-cost line of IBM punched card equipment can be installed with considerable saving in price over the heretofore minimum cost of a corresponding punched card system. IBM calls its low-cost line Series 50. A basic system can be installed for as little as $270 a month. This would include two of the Series 50 machines, a sorter and an accounting machine as well as a standard IBM 24 key punch.

Courtesy Stanford Research Institute



◄ View of magnetic elements made from materials like those used in fabricating cores for computer memory units. Termed "Mad," for multi-aperture device, they can perform computer "logic" functions more easily than previously possible with magnetic elements. With the "Mad," computer circuits for logic functions can be constructed using only the magnetic elements and interconnecting wire. (*Right*) Experimental model of shift register employing the "Mad" device.

Courtesy Stanford Research Institute



▲ Glowing electrical discharges, called "corona," are measured in GE's High Voltage Laboratory. Metal hood and doughnut provide uniform electrostatic field for precise measurement for Project EHV, experimental power line to carry super voltages higher than ever used by man.

Courtesy Allen B. DuMont Laboratories, Inc.

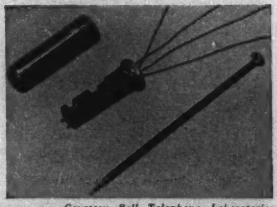
▲ Increased accuracy and speed in weather forecasting will be possible as the result of this new meteorological radar indicator developed for use by the U. S. Weather Bureau. Developed under a contract with Raytheon, it will supply accurate, long-distance information on weather conditions and is used in conjunction with a complete meteorological radar system to display highly accurate data on the range, azimuth, and height of storm areas, cloud formations, and other significant air masses. Its test azimuth accuracy is ±0.25 degree.

Westinghouse Photo

◀ A new Cypak control application this year is at New York International Airport's semi-automatic parking lot. As a driver approaches the lot, a magnetic coil beneath the road greets her by causing the ticket dispenser to stamp the date and time on a ticket. This done, she has only to pull the ticket from the machine. Again, the system anticipates her actions by raising the parking lot gate. The gate closes as she passes over a second magnetic coil. As if this were not enough, the Cypak system remembers exactly where each car is as it passes through the entrance. If for instance, a car is passing beneath the gate or is over the second coil as a second driver removes a ticket, the system leaves the gate up.

Courtesy Bell Telephone Laboratories

◀ View of the mechanized oracle, "Sibyl," which may help predict the future in communication devices and systems. Sibyl is composed of the computer-like machinery in the background which may be programmed to simulate the functions of a proposed service; the console (foreground), at which a human operator may be used as part of the simulation; and equipment for reading the results of the testing.



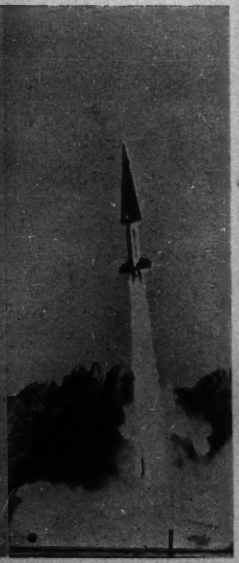
Courtesy Bell Telephone Laboratories

▲ A germanium resistance thermometer having high sensitivity and exceptional stability in the temperature range near absolute zero has been developed. Once calibrated, this thermometer is reproducible to better than a few ten thousandths of a degree at the boiling point of helium (4.2 K) even after repeated cycling from room temperature. Here it is compared in size with a common pin.

◀ Huge antenna detects distance, bearing, and altitude of multiple airborne targets for Frescanar, Hughes Aircraft Company radar developed for Army Signal Corps. Antenna shown is housed in clear plastic radome for display. In operation, opaque radome would be used for protection against elements. At right is Dr. N. A. Begovich, director of engineering, Hughes Ground Systems Group; E. W. Templin (*left*) is systems evaluation engineer.

▲ Miniature radio which proclaimed the Vanguard satellite's first successful flight into space is examined by Frank Wishneski, the International Telephone and Telegraph Corporation engineer in charge of its production. Known as DOVAP, this unit sent back trajectory and velocity data and other information on the first- and second-stage Vanguard missiles.

◀ Nike Hercules system tests are performed at the Western Electric Company's Burlington, N. C., plant. Antennas are shown atop the systems test building. (*Lower left*) Nike Hercules missile shown resting on a launcher. (*Below*) Missile takes off.



▲ Unique electronic equipment for automatic watt-hour meter testing has been developed by GE's Meter Department. The electronic test unit (ETU) was developed for utilities that require fast, laboratory-accurate testing of large quantities of single-phase, self-contained meters. ETU provides a large, direct digital read-out of per cent registration and has provision for automatic print-out, or IBM-type card or tape punch-out.

▲ Dielectric constant and dissipation factor of low-loss solid insulating materials can be measured directly and easily in the 200 to 5,000 mc range with the General Radio Type 874-LM Dielectric Measuring Line. Instrument is a slotted line also arranged as a sample holder accommodating cylindrical samples up to 45 centimeters in length. Coaxial line has one end open-circuited, simplifying mechanics of sample insertion and removal.

◄ New vibrating capacitor has excellent drift characteristics and minimal leakage. Developed by Tracerlab, Inc., for industrial use, it is little affected by temperature changes over a wide thermal range. No shock mounts are required. Capacitor assembly is hermetically sealed and filled with inert gas to minimize drift in constant potential.

► *H-6*-type leak detector—probe and control box complete—has 10-pound shipping weight. Probe is 7 inches long with one-inch diameter. It is connected to control unit with 6 feet of tubing. Control box is 8 by 6 by 3½ inches, connected by 12-foot cord to 115-volt outlet.

Courtesy General Electric Co.

Courtesy General Motors Research Laboratories

▲ D-c hysteresis loops can be plotted accurately in less than a minute with this semiportable hysteresigraph. GM's compact unit is built around a galvanometer amplifier system having a d-c open-loop gain of approximately 30 million and a sensitivity of between 3 and 20 Maxwell turns.

▲ This Velocity Torsiograph developed by GM Research Labs measures torsional vibrations of 5 to 900 cps at points completely inaccessible to conventional units. It has no seismic element to limit the minimum frequency or maximum amplitude of vibration that can be detected and its compact pickup has little effect on inertia of even small rotating parts.

▲ GE's 96-pound turbonator consists of a 24,000 rpm axial turbine on a common shaft with a high-speed alternator, producing 40 kva at 400 cps.

(Upper Right Photo) Automatic decoding and printing of "captions" from U. S. Air Force reconnaissance photos is performed by a Digital Data Recording device developed by ITT Laboratories. The coded information which includes the plane's position, altitude, and other data vital to the correct evaluation of reconnaissance photos, appears on the screen in front of the model. The decoded data is shown on the circular screen, left, exactly as it will be printed beneath the target photo. *(Upper Left Photo)* View of lower Manhattan showing the coded information and corresponding caption at bottom of photo.

Courtesy Sylvania Electric Products, Inc.

▲ Compact, transistorized electronic subsystem for military aircraft was developed through Sylvania's modular approach which achieves high performance quality without creating production problems.

Courtesy Stromberg-Carlson, division of General Dynamics Corp.

▲ A gigantic loudspeaker, rated at 1,000 watts and weighing about 150 pounds and believed to be the most powerful single acoustic reproducer ever built, will be used in research into the effects of high intensity noise on components and structures of missiles and jet aircraft at the Convair Division of General Dynamics Corp. in San Diego, Calif.

▲ This test facility at Westinghouse aircraft equipment department evaluates performance of aircraft fuel pump motors while they are submerged in high-octane fuel under a wide range of simulated conditions of altitude, heat, and cold.

▲ Tradic's new version, the first transistorized electronic brain for automatic bombing and navigation, gets a check at Morristown, N. J., by some of the Bell Telephone Laboratories engineers who designed and built the electronic system. The new Tradic is the fastest airborne digital computer system available. It can perform 62,500 basic computations per second.

Courtesy Stanford Research Institute

▲ This machine winds multiturn coils on extremely small cores through holes no larger than the eye of a small needle. This helps fill a demand for small components wound with multiturn wire coils. Insert shows a tiny coil that is size of FDR's eye on United States dime.

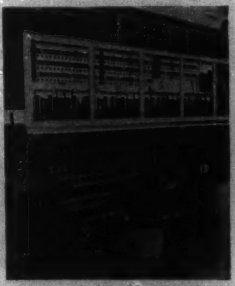
Courtesy Hughes Aircraft Company

▲ This completely automated line of machine tools is operated by the Hughes electronic control system and governed by transistorized digital computers. Three machines shown demonstrated automatic performance of all steps in milling, drilling, and boring. Punched tape reels (*right background*) gave orders to machines. Technician has only to feed a casting to the line and remove the finished part after it has been machined.

Courtesy Stromberg-Carlson, division of General Dynamics Corp.

▲ This automatic transistor testing machine, requiring only one operator for loading, automatically sequences transistors through 7 test stations. It was built for Sperry Gyroscope Co.

► A 10 to 15% increase in production because of reduced downtime with static control is expected with a spark plug assembly machine at GM's AC Spark Plug Division plant in Flint, Mich. Static control logic elements have no moving parts. Life expectancy is considerably longer than with conventional controls. Built by Helfrecht Machine Co., the machine uses a control panel with 127 GE static control logic elements.



Courtesy General Electric Co.

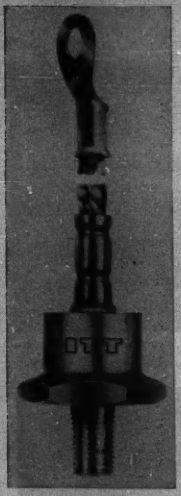
▲ View of automatic test unit for electron tube manufacture designed by CBS-Hytron. Tubes are mechanically transferred from the aging conveyor (*left*) to the automated tester (*right*) where they undergo up to 27 electrical characteristics tests controlled by adjustable plug-in units.

Westinghouse Photo

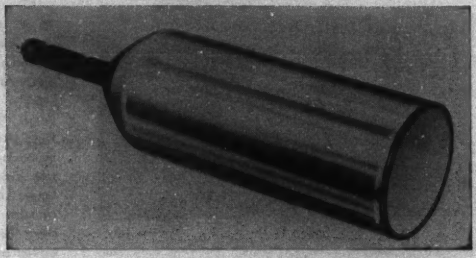
▲ Completely automatic operation is possible for a reversing roughing mill placed in production at the Aliquippa Works of the Jones and Laughlin Steel Corp. in early 1958. Under this new card-programmed system the mill operator can press a single button to initiate the complete rolling sequence for a given slab.

Courtesy Allen B. Du Mont Laboratories, Inc.

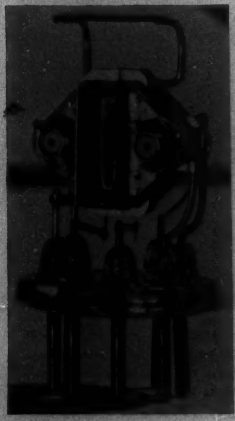
◀ A radar image can be frozen for more than 5 minutes on screen of this 15-inch direct-view cathode-ray storage tube. Such tubes have become indispensable devices for military, industrial, and laboratory equipment where retention of electronic images is necessary. (Above) View of direct-view storage tube which comes in 5-inch, 10-inch, 15-inch, and 21-inch screen sizes.



◀ The Components Division of ITT has a line of diffused-junction silicon power rectifiers rated from 5 to 70 amperes at a case temperature (with normal convection-cooling) of 150 C. These ratings can be increased by forced air cooling and apply at peak inverse ratings up to 800 volts. The rectifiers feature standard and proposed JETEC case designs using ¼"-28 studs up to 20 amperes and ⅜"-24 studs for higher currents, true dual hermetic seal, very low forward drop and low reverse current.



▲ CBS-Hytron's new ultrahigh-resolution cathode-ray tube provides the microscopic detail and clarity necessary for the transmission of fine photographic information. Resolutions of 12,000 lines have been achieved in the 7-inch sizes. This is accomplished by the tube's small, uniform beam and its very thin phosphor screen of short persistence. The ultrahigh-resolution cathode-ray tube can be used in guided missiles, satellites and military applications where weight and space, as well as high performance, are important.



◀ Adapting principles of the revolutionary ceramic "stacked" tube, Sylvania has developed a new electronic tube-mount structure which enables the company to produce glass enveloped tubes capable of withstanding extreme conditions of vibration, shock, and fatigue. The mount employs a "planar" or sandwich-type structure.

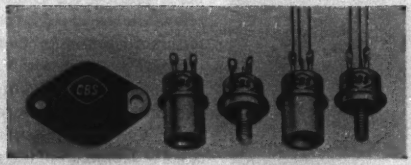
► A new type envelope, "the match box" design, applicable to complete line of receiving tubes and using the same electrode structure as conventionally designed receiving tubes has been developed by Westinghouse. Because of the envelope configuration, improved circuit performance has been obtained.

Courtesy Bell Telephone Laboratories

◄ Telephone lineman installing a plug-in unit in the terminal of a fully transistorized rural telephone system. In sending and receiving terminals, transistors are used as oscillators, amplifiers, and regulators, and for signaling. Providing telephone service to rural areas has long been one of the most difficult problems facing the telephone industry, both technically and economically. The newly developed transistorized carrier system shows great promise in helping to solve this problem.

► R. L. Carbrey holds two small regenerative repeater circuits. These transistorized circuits do the same job as the large vacuum-tube version on the table at the left.

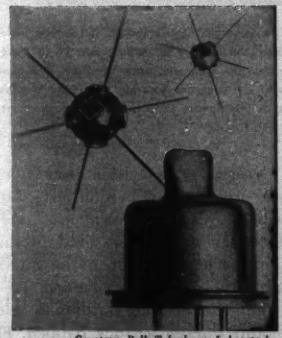
Courtesy Bell Telephone Laboratories



▲ Flexibility of line keynotes transistor production. CBS-Hytron manufactures its p-n-p germanium power transistors in a choice of these five different packages, 36 collector-to-base voltages and large signal current gains, and in 20-, 30-, and 40-watt sizes.

▲ View of 3 transistors showing sharp size reductions achieved by Raytheon Manufacturing Co. during 1958. The tiniest size is only 0.100 inch in diameter and 0.130 inch high. The "submin" or middle size is 0.130 inch in diameter and 0.160 inch high. The JETEC-30 which is the largest size is 0.370 inch in diameter and 0.260 inch high.

► Diffused base transistor of the type used in the transmitter of the Vanguard satellite. On satellite surface are "banks" of silicon solar cells which convert sunlight into electrical energy to operate the transmitter.



Courtesy Bell Telephone Laboratories

► Backed by an oscilloscope trace which shows its continuous operation, a tiny silicon carbide rectifier changes alternating to direct current while heated red hot with a torch. Developed by scientists at Westinghouse, the rectifier results from a new method for preparing ultrapure silicon carbide—a common material found in grinding wheels and lightning arresters. The rectifier is expected to find applications in the high-temperature electronic control system for rockets, missiles, and supersonic aircraft of the future.

(Continued from page 3)

Work of the Television Allocation Study Organization (TASO), almost completed, will provide a wealth of information for use as allocations tools in any future solution to television allocations and assignment problems. This work, to be completed early in 1959, is the product of almost 300 of industry's best engineers.

The Strategic Air Command (SAC) has installed an RCA closed-circuit television system at Offutt Air Force Base, Nebr. Installation comprises six color cameras used in a 6-channel closed-circuit system, with 12 program sources, to extend weather information and worldwide intelligence data to 16 key locations at SAC headquarters.

Nearly 200 television translators were installed this year to expand television service to the public, 95% of which already receive at least one signal.

Scatter transmitters hold promise of truly international television, depending on economics for implementation. Vastly expanded use of remote pickup equipment enables stations to televise events of paramount interest as they happen. FCC authorization of broadcast microwave intercity relays obviates the broadcasters' dependence on common carrier for program availability.

Educational television has had a steady growth since 1953 to about 40 stations early in 1959. Alabama and North Carolina have state networks in operation, while Florida and Oklahoma have such networks under construction.

General Applications

DOMESTIC AND COMMERCIAL APPLICATIONS

One of the most significant developments of the year in this field was, perhaps, the demonstration of appliances using the Peltier effect to produce both heating and cooling in the same device. This is an old principle, but recent developments by engineers in thermoelectric research in materials and techniques have brought its commercial possibilities much closer.

First devices to demonstrate the application of this principle are a baby bottle cooler–warmer and a hostess cart. The baby bottle cooler–warmer will keep the bottle cold until a predetermined time when it will be warmed to proper temperature. The hostess cart provides both a cooling compartment and a warming compartment which function at the same time. This principle could have extensive applications in the appliance field and also in home climate conditioning.

In appliances in general, the emphasis was on simplification of construction and ease of cleaning and service. Several range manufacturers introduced models with removable oven doors and one manufacturer developed a slide-out oven to facilitate cleaning. Noteworthy in the small appliance field are several models of spoutless coffee makers and at least one immersible model.

In the refrigerator of one manufacturer, the adoption of a new internally spring-mounted compressor made possible the consolidation of the motor starting relay, the overload protective device, the compressor terminal connectors, and external wiring terminals all into one package, which is mounted on the compressor terminals. This not only simplifies the electrical connections of the entire refrigerator, but also is much faster to wire and assemble, resulting in substantial cost reductions over the two-part combination required with the externally sprung compressor formerly used.

LAND TRANSPORTATION

The Pennsylvania Railroad, at present, is operating six new lightweight commuter cars, built by The Budd Company, in the electrified zone. These cars are propelled by four motors each through right-angle drives. The motors and gear units are close-coupled without a drive shaft. In electric propulsion drives, this is the latest development and is designed to save weight and space. New also is a combination of auxiliary machines in one set such as a motor–generator, blower, and circulating water pump set. Electric equipment of the car uses rectified power similar to equipments furnished previously to the New Haven Railroad on 100 multiple-unit cars, but this equipment has been streamlined and modernized to the extent that appreciable weight savings have been effected.

Rapid advances have been made in the use of computers for solving operational and design problems in the land transportation field. Computers are used in setting up classification yard operations and evaluating torsional problems on multiple take-off diesel engine drives, train resistance characteristics, train and vehicle performance, and others.

Transistors have been introduced for voltage regulators on multiple-unit car and bus auxiliary power supplies such as battery-charging circuits. Semiconductor power diodes have been applied also in blocking service to prevent battery discharge through auxiliary motor–generator sets when the motor–generator set is shut down.

Pennsylvania–Budd Pioneer III ignitron multiple-unit car for commuter service.

The Chicago Transit Authority (CTA) put into operation the new rapid transit line on the Congress Street combined highway and rapid transit right-of-way early in 1958. This is the outstanding development representing an integrated mass transit system. A co-operative development has also been started by CTA with electrical and mechanical equipment manufacturers to produce new experimental high-speed rapid transit cars for future applications to the Congress Street Expressway. Five cars are involved which will use different design trucks, different electrical drives and mechanical arrangements–some with close-coupled drives, others with the conventional universal joint drive. Different braking systems will be used. Approximately 11 manufacturing companies and the CTA are engaged in this co-operative research and development program which is aimed at providing maximum speeds of 75 miles per hour, long periods of acceleration at 3.5 miles per hour per second, and increased passenger safety and comfort.

PRODUCTION AND APPLICATION OF LIGHT

SEVERAL IMPORTANT ADVANCES in light sources, luminaires, and application techniques for the year 1958 warrant special mention.

Researches in lighting levels have contributed greatly to the fund of knowledge regarding proper seeing conditions. These researches, conducted over a period of about 8 years, again confirm that, for the vast majority of applications, lighting levels are far from the values necessary for optimum seeing. These studies have resulted in a re-evaluation of the recommended illumination levels by the Illuminating Engineering Society (IES) and the establishment of new recommendations. A new IES Handbook which includes these values has been prepared.

Acceptance of the need and benefits from higher lighting levels has accelerated in the past year in commercial and industrial applications. Factors which have contributed to this trend are better fixture designs, higher output sources, and lower lighting costs.

New arc tubes and electrodes developed by lamp manufacturers combine to improve the light output of mercury lamps at the end of 6,000 hours from 70% to 90% of the initial rating, thus extending useful life. Another achievement in mercury lamps has been the development in the lamp industry, through the American Standards Association, of a universal method of designating mercury lamps.

A 400-watt mercury lamp for 3.2-ampere straight series street lighting has been developed by the General Electric Company (GE). The lamp contains a built-in device which prevents false film cutout failures due to lighting surge voltage through the line.

A mercury luminaire for highway lighting is now available, incorporating a built-in ballast in its construction. This design tends to lower initial cost by simplifying installation. Other features may include better appearance, one-piece die-cast housing, completely sealed optical system, and a selection of ballasts including regulated output 120/240-volt, capacitor 240-volt, series type, and other multiple ratings.

With the trend toward more higher-wattage fluorescent lamps in street lighting luminaires, control of heat has become more of a problem. Units have been developed with thermostatically controlled fans to regulate luminaire temperature properly.

Mercury luminaire, OV-258, features 1-piece die-cast housing, sealed optical system, and built-in regulated output ballast with 120/240-volt connections.

Courtesy Westinghouse

To met the higher, more adequate footcandle levels, many new interior luminaires have been made available. Features include improved design, easier installation, and improved maintenance characteristics. However, the one feature emphasized by most manufacturers is comfort. This has been achieved through better shielding, more upward light, or improved louver design.

Another important development has been the introduction of a new Sterilamp by Westinghouse which produces a radiation which is about 100 to 1,000 times more effective in killing bacteria, virus, and molds.

Glowing electroluminescent panels, developed by Westinghouse Research Laboratories, are now available for display lighting, safety night light, and such places as military aircraft, industrial processes, and instrument panels.

Industry

FEEDBACK CONTROL SYSTEMS

THE CONCEPT of feedback control systems gradually is being broadened to include several other important functions which round out the automatic control field. In addition to servomechanisms and regulators, equipments which serve such functions as programming or guidance, telemetry or data transmission, data presenting or data processing, instrumentation or sensing, computing or logic are receiving increasing attention by feedback control engineers to determine their effect on over-all systems' performance. The achievements outlined serve to emphasize these expanding fields of

interests as well as the increasing effort being placed on control systems' components.

Two Explorer satellites, one Vanguard test ball, and a semisuccessful lunar probe by the Pioneer rocket not only signal the beginning of the space age, but also emphasize the importance of pushing back the frontiers of control technology to solve the attendant control problems. Precise and reliable miniature control components capable of operating at extreme environmental conditions, airborne and groundbased control computers, advanced telemetry and tracking techniques, and improved system analysis and synthesis procedures have made possible these initial space penetrations. Continued breakthroughs in these areas will be necessary to further space flight.

One of the major factors in the success of missiles and space vehicles has been the inertial guidance systems, incorporating precise new types of gyroscopes and accelerometers. Its use is not limited to airborne vehicles, the nuclear-powered submarine *USS Nautilus* on its historic cruise under the North Pole being navigated by the inertial guidance system originally developed for the North American Aviation, Inc., Navaho missile. The Navy's Project Subic aims at systems engineering a submarine as though it were a space ship, so that a submarine can be "flown." Ship control, engineering control, communications, casualty control, environmental control, and weapons or fire control are to be integrated into one over-all system with control exercised by one man.

Communication and data processing techniques have proved their worth in calculating and relaying guidance commands to space vehicles and missiles, and in gathering, evaluating, and displaying data telemetered back from the space vehicle.

Simulation techniques and advanced test procedures have become powerful tools in the synthesis of control systems. Convair, Astronautics, and Ramo-Wooldridge all have interconnected large-scale analog and digital computing facilities to obtain the benefits of combined simulation. In another example of simulation, the giant Polaris missile launcher at Cape Canaveral simulates the sea by shaking the entire missile in accordance with a predefined program. Future plans include recording actual ship motion and playing it back through the shaker.

A step forward was taken in the program control of steel rolling mills by the delivery of the control systems for a new structural mill at the South Works of United States Steel Corporation. Westinghouse supplied the blooming mill control, and GE the forming mill systems. Both program controllers make substantial use of static switching devices; Westinghouse uses transistor NOR units and GE uses magnetic devices. The mill is expected to go on line during the spring of 1959.

The first evidences of operating automatic warehouses came on the scene during 1958. The honors for first and fanciest went to an automatic order-picking machine for filling drug orders at a rate of one every 15 seconds. Designed by Industrial Electronics Engineers, the order-assembling system is installed at the Brunswig Drug Company in Los Angeles, Calif., where its punched-card control permits rapid selection from a stock of 1,600 different products. Other examples of automatic warehousing and materials handling techniques are the electronic mail sorter designed for Stewart-Warner Electronics for the Pennsylvania Railroad's 30th Street Station in Philadelphia, Pa., and the Lamson–GE static-shift-register automatic dispatching system installed at the Crockett, Calif., refinery of the California and Hawaiian Sugar Refining Corporation.

GENERAL INDUSTRY APPLICATIONS

Materials Handling. During 1958, many records were broken with respect to ratings of heavy materials handling equipment. An eastern steel mill installed three 500-ton ladle cranes, each with a total of 1,660 hp in motor nameplate ratings. The Lukens Steel Company installed a soaking-pit crane to handle tremendous ingots weighing 75 tons each, and the use of front-connected d-c crane panels saved valuable end-approach space.

Among the most interesting bulk-materials-handling installations during 1958 were the three European type "slewing jib" adjustable-voltage operated ore unloaders at Chesapeake & Ohio Railroad (C & O) Newport News (Va.) Docks, and the 6,000 ton per hour coal-dumping and ship-loading C & O Presque Isle facilities.

The U. S. Post office is taking a major step in the automation of mail handling by the installation of "Mail-Flo Systems" in the post offices of five large cities. Each installation utilizes several hundred motor-driven conveyors and 40 or 50 centralized control stations. The integrated system automatically routes batches of preselected quantities of letters from one sorting station to another by means of a card-reading system.

A new "milestone" in the development of a-c crane control was attained by the introduction of the GE *7400* line, which includes a hoist circuit that provides stepless static control from full speed in either direction, through standstill, to full speed in the opposite direction.

An electrically operated brake with adjustable, controlled torque for smooth and accurate stopping of crane bridges, trolleys, coke oven machinery, and transfer cars has been developed by the Electric Controller & Manufacturing Company, a Division of Square D Company. In addition to controlled torque, the brake features spring-applied emergency torque on power failure and for parking. Because of the all-electric operation, the brake may be operated through collector bars and is particularly appropriate for use on floor-operated cranes controlled from pendant master switches.

Textile Industry. Two significant developments in electric drive systems for textile machines were installed in textile mills in 1958. Both utilize the higher efficiency, accuracy of control, lower maintenance, and smaller size which are characteristic of static devices.

One application consists of a speed-regulating static power supply fed from 60-cycle lines for an adjustable speed d-c motor. The d-c motor drives an alternator which can supply adjustable frequency power to groups of motors on pumps, feed wheels, and wind-up drives on synthetic yarn spinning machines. Speed control of ± 0.1% is obtained through a transistorized speed-regulating system controlling magnetic amplifiers. Other installations feature range drives and controls for textile finishing machines in sizes of 15 to 150 hp.

In the larger sizes, induction voltage regulators are used to supply adjustable a-c voltages to static rectifiers for supplying d-c power for the groups of d-c motors driving the finishing range. The smaller drives are somewhat similar except for the use of saturable reactors feeding the static rectifiers.

Both developments have supplanted the conventional motor–generator equipment previously used for similar applications.

INDUSTRIAL POWER RECTIFIERS

A 3,000-KW 300-VOLT silicon rectifier was put in service in the Hercules Powder Company's plant in Hopewell, Va. This unique rectifier is the first large semiconductor rectifier equipped with voltage-divider transformers, current-balancing reactors, and a closed-circuit water-cooling system using deionized water to eliminate electrolysis and corrosion.

Its application is even more unique in that it feeds a large chlorine plant in parallel with a mechanical rectifier and two rotary converters. Although the mechanical rectifier is subject to backfires just as any other rectifier, and these backfires constitute a bolted short on the d-c bus, the protective equipment has completely prevented any damage to the silicon rectifier. The rate of cell failures in this installation has been lower than anticipated.

The entire equipment is outdoors and, because of special conditions, it is direct cooled by forced air. Air enters through special louvers and filters in the doors of the rectifier compartment directly in front of the silicon-cell assemblies and is discharged through a power roof ventilator.

The air is drawn at high velocity through cooling fins attached to the bus bars on which the cells are mounted. Cell mountings, bus arrangements, and balancing iron are very similar to the standard water-cooled rectifier.

METAL INDUSTRY

OF SIGNIFICANCE in the metals industry is the rapid increase in applications in which the process itself is a part of the feedback control and drive systems "loop." This year, for example, saw the installation of the first completely automatic rolling mills which roll a slab of steel through a program of several reversing passes from directions on a punched card. The punched card directs the main drive motor, roll screwdowns, tables, edger, etc., to the proper speed, direction, or position for each pass. The hot steel is brought within the control loop, since the equipment is controlled by means of optical devices which continuously observe the steel and sequence the program control as each operation is completed.

Courtesy United States Steel Corporation

Long lengths of red-hot steel enter rolling mill finishing stands at Columbia–Geneva Steel's Geneva works, where new electronic system for rolling hot strip steel automatically to a uniform thickness went into operation recently. The system will insure higher quality in steel products rolled at the U. S. Steel plant and also will increase steel yields. Inside control booth, W. R. Boyack, roller helper, is shown operating control panel for the self-regulating system.

Another example of placing the process inside the loop is automatic gage control. Gage control for cold reduction mills is in wide use, but 1958 saw the world's first automatic gage control in operation on a hot strip mill. Process information is fed electrically into the control system by X-ray thickness gages and by load cells which measure rolling pressure. These signals are combined and vary the mill speed and screwdowns to produce hot strip of constant thickness. This development required extensive analysis of the rolling process as well as the mechanical and electric equipment, inasmuch as they all are part of a complex feedback control system.

A similar example of process control is gage control for aluminum foil mills. To obtain needed information on the rolling process portion of the loop, a technique was borrowed from the systems engineer and applied for the first time to the rolling mill itself: frequency response tests were made by varying mill speed sinusoidally to determine the effects of frequency of oscillation on foil thickness.

A final example of a system which includes the process inside the control loop is the reel control for a Sendzimir rolling mill. Whereas previous controls regulated reel motor current as an approximation of tension, recent drives have used a load cell to give a true indication of tension in the metal strip which passes over a pivoted roll.

Automatic digital data recording has been installed

this year on several electrolytic tinning lines. This equipment inspects the tin-plated strip as it is manufactured, and automatically records on an electric typewriter the quality of each foot in a coil of tinplate.

Further developments were seen in rectifiers for motor drives. Installations were made of silicon rectifier power supplies for several steel-processing lines to provide a static low-maintenance equipment of high efficiency. The use of mercury-arc rectifiers continues to expand to both larger and smaller drives. A large 10,000-hp Lukens Steel Company reversing mill drive is now being installed. This year saw the use of small mercury-arc drives for reversing duty on shear drives which must accelerate and decelerate extremely rapidly.

MINING INDUSTRY

UTILIZATION of 440-volt a-c power continues to find wider use in underground mines. Approximately 40% of the machines built today are a-c powered, as compared with about 10% as recently as 3 years ago.

Several machinery manufacturers have built mining machines which are operated by remote control. Up to 25 machine motions can be controlled accurately, through a multiconductor control cable, by the machine operator when he is standing more than 50 feet away from the machine. This feature gives the operator more freedom to co-ordinate the operation of the face machine with other machines and allows him to work in the safest area available within the limits of the length of the control cable.

For several years a large chemical manufacturing company has been developing a coal mining machine that will mine outcropping coal to a depth of 1,000 feet and be completely controlled by one man standing outside of the mine, thereby making it unnecessary for any men to enter the mine. This machine was acquired recently by a leading coal mining machinery manufacturer and is being offered for sale. Tons produced per man-shift are five to six times the national average and the problems of mine ventilation, roof support, drainage, and other requirements associated with deep mines are eliminated in some and greatly reduced in other cases. Greater safety also is enjoyed by the men running the machine. Machine sensing, for learning position and condition of operation and machine manipulation, for locating the machine in optimum positions in the coal seam, are handled through a combination of electronic devices and relays. This machine bridges the gap between deep mining and strip mining by making available millions of tons of coal that cannot be mined safely and economically by deep mining, yet are buried too deep for strip mining.

The ever-present threat of methane explosions in coal mines and resultant loss of life and property is causing M. J. Ankeny, director of the U. S. Bureau of Mines, and his associates to encourage the development, sale, and use of a continuous methane detector which will dependably reveal the presence of methane before it reaches explosive concentrations. It will be connected to the electric circuit of the machine and shut down all machines in a working area where methane is found in concentrations of 2 to 2.5%. Several companies are working on this project and it is sincerely hoped that a practical device will be available in the near future.

Mr. Ankeny and his staff also have encouraged the development and use of a device to replace the safety ground wire normally required in rubber trailing cables supplying power to mining machines. Several of these devices have been placed in service on machines operating on 250 and 500 volts, d-c.

The safety features of ground wires in portable high-voltage distribution cables have been improved by the use of a circuit which continuously monitors ground wires. If a ground wire breaks, this causes a circuit breaker to open and remove power from the circuit served by the cable with the faulty ground wire.

A word of commendation should be extended to the officers and members of the Mining Electro-Mechanical Maintenance Association for their continuing efforts to educate the men using and maintaining mining machines so that the latest engineering concepts in mining machines are given more intelligent handling.

Instrumentation

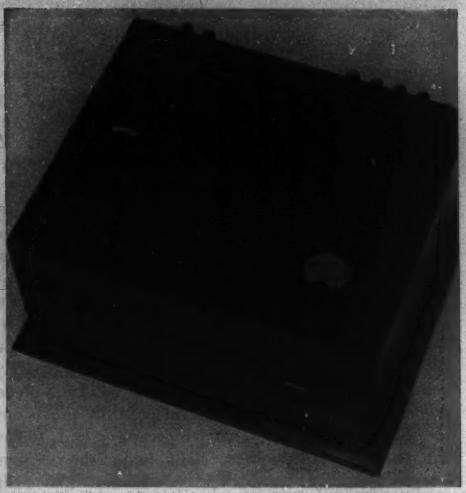
ELECTRONIC AND HIGH-FREQUENCY INSTRUMENTS

DURING 1958, there has been a notable increase in application of electronic instruments to process control. Interest in electronic process control instrumentation has been strong for a number of years, particularly where control signals must be transmitted over long distances, and several systems have been available commercially. This year, however, many of the major instrument companies introduced new instrumentation emphasizing miniature size and solid-state electronic circuitry for measurement and control of temperature, pressure, flow, liquid level, and other process variables.

Ballantine Laboratories, Inc., reports impressive life-test results on their model *300-D* electronic voltmeter, which was designed to meet long-life and high reliability requirements. Projected results indicate that most production instruments should operate 2,000 to 4,000 hours (1 to 2 years of normal use) before tube replacement or recalibration is required.

INDICATING AND INTEGRATING INSTRUMENTS

IMPORTANT CONFERENCES held during the past year have emphasized the growing requirements for increased accuracy in electric instruments and auxiliary measuring apparatus. These requirements, which have been brought about chiefly by military developments, have led to a phenomenal increase in the number of standardizing laboratories in military establishments and in manufacturers' plants. The organization and operation of such laboratories and recent developments in standard instruments for calibrating other measur-



Wide-range volt-ampere converter, for measuring alternating current and voltage to 0.05% at frequencies from 5 cps to 50 kc, was developed by the National Bureau of Standards for its new calibration center at Boulder, Colo. It has 11 current ranges from 7.5 ma to 20 amperes and 12 voltage ranges from 0.5 to 600 volts.

ing apparatus were discussed in several papers at a 3-day conference in August. This conference, attended by over 900 people, was held in connection with the dedication of the calibration center at the Boulder (Colo.) Laboratories of the National Bureau of Standards (NBS).

A conference on the statistical basis for the sample-testing of watt-hour meters was held at the AIEE 1958 Winter General Meeting, giving general recognition to the aims and problems of this new approach to insuring the accuracy of meters in service.

A number of developments in commercial instruments, announced during the year, have demonstrated advances to meet requirements for increased ruggedness and reliability, such as the use of taut-band suspensions, molded core-magnet structures, and light-beam pointers.

RECORDING AND CONTROLLING INSTRUMENTATION

In 1958, large advances were made in instrumentation for control of industrial processes. New principles were applied in the design of the transducers, controllers, recorders, and valve operators. The trend toward use of transistors and magnetic amplifier components in place of vacuum tubes was evident.

Transducers converting mechanical and electrical measurements to proportional electrical signals for transmission between the instrumentation units became available in several forms. Electronic controllers providing proportional, reset, and derivative functions are provided in readily replaceable plug-in units. Recorders used with these control systems are of miniature size, employing 3- or 4-inch strip charts. A novel electrical–thermal valve arrangement, which operates on the basis of controlled rate of heat release through Freon in a closed system, was introduced. This power device eliminates the need for an air supply for actuating the control valve.

Another miniature recorder, of plug-in design, utilizes a 2-phase motor for recording and for operating other attachments, such as pneumatic transmitters, control and alarm switches, and retransmitting slidewires.

Several improvements in self-balancing wide-chart recording instruments have become available. Integrating attachments for marking on the chart the area under the curve being traced are used for gas chromatography analyses. A multiple point recorder with a simple attachment kit for changing in the field the number of points to be recorded was introduced. New 3-term controllers, 2-pen recorders, curve peak detecting mechanisms, and instrument cases suitable for direct mounting on standard relay racks became available.

Direct-deflecting millivoltmeter-type instruments with adjustable proportional band feature and magnetic amplifiers have been used to provide temperature control through saturable core reactors.

Model 663 miniature strip-chart self-balancing potentiometer recorder incorporating pneumatic transmitter, designed and developed by the Bristol Company.

Analog and digital computing and recording instrument systems have been combined with supervisory control and telemetering devices for the operation of widespread gas transmission and distribution networks.

SPECIAL INSTRUMENTS AND AUXILIARY APPARATUS

Several recent instrumentation developments which cannot be identified with any particular field or industry are worthy of note. One is the advance made in the development of precision resistors of the metallic-deposited type such as nickel–chrome alloy deposited on the inside of glazed ceramic tubes, the Vamistor produced by Weston Electrical Instrument Corporation in 1958 being an example.

In the general field of solid-state electronic engineering, the commercial availability of devices using the phenomena known as the Hall effect is of interest. Detection elements made of such materials as indium antimonide and indium arsenide in small thin wafers can be used to measure currents or magnetic fields. Ohio Semiconductors, Inc., announced the availability during the past year of Halltron devices based on the Hall effect principle.

In the field of high-voltage measurements, further progress has been made in the accuracy of measuring high-voltage impulses, in assessing divider response, and in calculations of possible errors for various applied wave shapes, including the effect of the resistance of cables which transmit the signals from the dividers to the recording oscillographs. Generally applicable methods for determination of divider response and accuracy have been explored. Data have been collected and presented concerning the effect of water resistance and rate of precipitation on the flash-over voltage during wet tests for comparison in connection with standardization work with the International Electro-Technical Commission.

Progress has been made in improving measurement techniques involved in the study of corona effects in dielectrics. More reliable and higher sensitivity measurements of corona inception voltages and corona charges in high-voltage insulation systems have been provided in corona detection equipment made available during the past year.

The need for more efficient loading of electric power distribution cables in underground ducts calls for duct-line temperature surveys which has made necessary the development of a rapid-response resistance thermometer probe, that can be drawn through a cable duct and temperatures measured over its entire length. Such preliminary surveys determine the ambient temperatures to which the cable installation will be subjected. A resistance thermometer sensing element recently developed consists of a small phenolic wafer in which is embedded a 0.8-mil nickel wire.

Power

INSULATED CONDUCTORS

SUBSTANTIAL PROGRESS has been made on two research projects of great importance in the field of insulated conductors.

The jointly sponsored AEIC–EEI (Association of Edison Illuminating Companies–Edison Electric Institute) research project for the field testing of extra-high-voltage cable and accessories has advanced to the stage where the co-operating cable and accessory manufacturers, comprising Anaconda Wire and Cable Company, General Cable Corporation, The Okonite Company, Phelps-Dodge Copper Products Corporation, G & W Electric Specialty Company, and Ohio Brass Company, have announced the type of cable systems in the 345- to 400-kv range being offered for field testing. A low-pressure oil-filled self-contained lead-sheathed cable system, two high-pressure oil-filled pipe-type cable systems, and a high-pressure oil-filled self-contained aluminum sheathed cable system are being proposed by these respective cable manufacturers in the order mentioned. The cables will be insulated with oil-impregnated paper tapes. The cable samples are being developed and supplied by the manufacturers at their own cost.

The field testing project itself is being financed by contributions from 25 individual utilities which together with those of AEIC and EEI now assure the undertaking. Various electric equipment manufacturers, including GE and Westinghouse, and several disconnecting-switch manufacturers, have offered important components to be used in the construction of the test substation on a free-use basis. Plans are actively being pursued to design a nominal 345-kv 3-phase test substation at Cornell University with provisions for load cycling at elevated temperatures and, under voltage on a single-phase basis, with the various samples installed under field conditions. The field tests are scheduled to begin late in 1959.

Active research work on the thermal resistivity of soils carried out at Princeton University in the Soil Physics Laboratory during the past 3 years ended on August 1, 1958. After a review of the literature on past work in this field, the laboratory studies were aimed to investigate, in addition to the basic parameters of soil moisture content and soil density, the effect of secondary factors such as soil granulometry and structure. Work was also done in studying the effect of the thermal gradient in producing migration of moisture in the soil adjacent to underground electric cables.

An AIEE Subcommittee has now begun the task of digesting the scientific information developed from these studies with a view to preparing a report for industry use on the engineering application of this information. The report will be presented as an AIEE Committee Report at a forthcoming AIEE General Meeting. However, it is expected that the work of preparing this report will not allow presentation before the 1959 AIEE Summer General Meeting, at the earliest.

POWER GENERATION

THE AVERAGE SIZE of steam–electric generating units on order and being considered continued to increase during the year. The largest unit now on order is a 3,600/1,800-rpm cross-compound unit rated 500,000 kw, but even larger units are being developed and seriously considered for the near future by several utilities.

After very rapid advances in steam temperatures and pressures during recent years, there appears to be a temporary leveling off at about 3,500 psig and 1,050 F to consolidate experience at this level and to permit effective evaluation of the economics of these advanced steam conditions.

A trend which seems to be growing is that of re-

Courtesy Westinghouse Electric Corporation

The Shippingport Atomic Power Station, dedicated in May 1958, is first full-scale central station atomic power plant in the United States devoted entirely to civilian use.

viewing more critically the necessity for spare capacity in station auxiliaries, particularly in boiler feed pumps. Several units are now in operation, with many more planned, in which a single boiler feed pump with essentially no back-up is being used.

Increased attention has been given during the year to the possibility of automatic operation of large generating units and to the use of data-logging equipment.

The Shippingport (Pa.) Atomic Power Station, which first reached full power in late December 1957, was formally dedicated on May 26, 1958, as the first commercial size atomic power station devoted solely to civilian uses. This 68-mw (100-mw ultimate) gross generating capacity unit represents an important milestone in American progress toward competitive atomic power and is furnishing valuable design knowledge and operating experience.

POWER SYSTEM COMMUNICATIONS

CONTINUED PROGRESS has been made in automatic economic load dispatching. A number of smaller organizations have completed the installation of such systems and many more are in various stages directed toward the final objective. The over-all function makes use of different facilities which, in themselves, have had separate treatment. Briefly, the over-all operation consists of accumulating the system-load or interconnected tie-load data of a system and transmitting it to a load center. The next step has been to transmit this data to a computing center at which point it is programmed into a computer. The output of this computer is then transmitted directly to the separate generators to furnish the most economical power for a specific load, taking into consideration such things as line losses, fuel costs, plant costs, etc. In many cases, an intermediate step provides for manual operation with the output of the computer available to the dispatchers.

It readily can be seen that such a function requires the maximum in reliability to accomplish the desired results successfully. This has resulted in much competition among the transmission facilities, such as power-line carrier, microwave, telephone-line carrier, and leased circuits. It can be said that the objective has been achieved, but there will be much improvement in these various units to better the end results.

There are several other accomplishments that might be listed as achievements. One is the use of single sideband in power-line carrier to provide a better quality circuit and more economical use of the carrier spectrum. This has been used in Europe for several years but has only been accepted in the past year in this country.

Another development that has attracted attention is the use of "broad-band" coupling in power-line carrier. To some extent, this is a new application or arrangement of existing units, but new units also have been offered which have resulted in more economical coupling for these circuits. Some installations completed in the past year have shown the improved economics and reliability of such an arrangement.

RELAYS

AN IMPORTANT DEVELOPMENT announced during the year was a new high-speed differential relay for protection of 2- or 3-winding transformer banks. This single-phase relay consists of a differential unit which is supervised by a second-harmonic restraint unit. The differential unit distinguishes between internal and external fault currents, whereas the second-harmonic unit differentiates between inrush and fault currents. The design has an operating characteristic which provides maximum sensitivity for light internal fault currents and reduced sensitivity during heavy external fault currents when current transformer saturation may be of concern. The relay has built-in ratio taps to compensate for mismatch of line-current transformers. The impedance characteristic of the tuned circuits in the harmonic restraint unit also permits detection of faults at low frequencies during generator warm-up periods.

Another item to be noted is that outstanding progress is being made in the art of distribution line relay protection as related to fast fault clearing and fast reclosing of distribution feeders. This was evident from a group of papers on distribution line relaying prepared for presentation at the AIEE 1958 Fall General Meeting which was unavoidably cancelled. Protection is being related to present-day distribution line designs which are going through drastic changes. These changes are necessary in order to keep up with present-day fast growing loads on urban and rural distribution lines with the added exposure associated with higher voltage primary distribution. These papers and others to come are tending to emphasize the widespread necessity for adequate engineering studies. These studies will be required in order to provide protection and reliable service at reasonable cost to millions of customers connected to present and future distribution lines.

ROTATING MACHINERY

NUCLEAR POWER STATIONS have steam conditions that require the use of 1,800-rpm generators. The largest generator to be built at this speed is now being manufactured by Westinghouse for the Indian Point Nuclear Power Station of the Consolidated Edison Company (Con Ed) of New York and is rated at 330,000 kva.

Conductor cooling is being used in a greater percentage of large generators. GE has announced that they are developing the use of water as a coolant for generator stator windings.

New impregnating resins and mica bonds with epoxy-like linkages in the resin structure and elimination of cellulose from the insulation wall are improvements in insulation of stator coils in Westinghouse large high-voltage hydrogen-cooled turbine–generators. Longer life at high temperature results from this changeover, completed in 1958. Allis-Chalmers Manufacturing Company (A-C) used a glass-reinforced epoxy rotor-slot channel, superior to their earlier construction strength and heat transfer properties.

Partially machined 4-pole rotor for Indian Point Nuclear Power Station of the Consolidated Edison Company of New York. This Westinghouse tandem compound 1,800-rpm machine, rated 330,000 kva, uses inner cooling of both rotor and stator.

Two manufacturers have announced the use of brushless exciters on small generators. An a-c generator excites the field of the main machine through a rotating silicon-diode rectifier. All brushes, commutators, and collector rings are eliminated.

A new arrangement of ventilating air for large motors, which features straight-up discharge to permit locating machines closer together, is used by Electric Machinery Manufacturing Company. Also, GE has developed an extremely low-speed d-c motor to provide precision drive for radar antennas. Direct connection eliminates backlash errors at speeds from 1/360 to 5 rpm. Large induction and synchronous motors built by Westinghouse use electrical and mechanical parts less dependent on each other. Various enclosures can be used with the same active parts and such enclosures are removable for easy access.

SUBSTATIONS

SITE PROCUREMENT difficulties and costs continue to influence new substation installations. Bulk substations stepping down to 13 kv in metropolitan areas to serve as much as 150 to 250 mva of load are being installed by several companies. In urban and suburban areas, distribution substations of larger size and higher voltages are being used, with greater attention to appearance and some increasing tendency to be located in buildings or underground. Distribution substations stepping directly from 230 kv to 13 kv have been installed by two companies.

Usage of aluminum for outdoor substation buses continues to increase, particularly field-welded construction. During 1958, several companies also installed outdoor structures fabricated from aluminum to explore the improving first cost comparison of aluminum vs galvanized steel, particularly for lower voltage and minimum height installations.

Increasing usage is being made of automatic oil-circuit reclosers in lieu of circuit breakers in the smaller sizes of distribution substations.

Static switching devices are beginning to find use in automatic switchgear control boards, as illustrated by the partially automatic starting static control furnished for two 7,500-hp gas turbines. Control power supply from a 125-volt battery was made possible by the development of static inverters to supply up to 2 kw at 115 volts a-c, a d-c supply unit for the logic elements, and d-c static switches for controlling the fuel and other solenoids requiring over 10 amperes d-c. Newly developed static-control time delay circuits provide time intervals adjustable up to 5 minutes.

Two newly developed arrangements of outdoor metal-clad switchgear permit reductions in required aisle and foundation requirements and offer the convenience of indoor construction with respect to control, testing, and maintenance.

SWITCHGEAR

ADVANCES in oilless power circuit breakers rank high on the list of switchgear developments for 1958.

With full realization of both the severity of recovery voltage conditions which exist in the high-power systems of the United States, as well as the importance of recovery voltage requirements on the performance of many types of oilless circuit breakers, American manufacturers have recently announced important high-voltage oilless power circuit breaker developments.

One company has introduced a line of high-voltage outdoor air-blast breakers for 115 kv through 460 kv. Orders from 115- through 230-kv ratings have been accepted for 1959 shipment. These breakers are of modular construction and feature a new gas-insulated current transformer as an integral part of the breaker

Courtesy Westinghouse Electric Corporation

Outdoor metal-clad switchgear arrangement with enclosed control and breaker withdrawal aisle.

structure. A special ground current unit facilitates the use of current transformers on only one side of the breaker. Interrupting ratings equal the maximum American Standards Association C-37 requirements.

Another company has accepted several orders for 138- and 230-kv high-kva SF_6 filled power circuit breakers for delivery in late 1959. These are the first of a complete line of outdoor dead-tank gas breakers extending in rating to at least 460 kv, with an interrupting capacity of at least 35,000 mva.

As a result of a demand for faster breakers to improve distribution line burn-down experience, 2-cycle magnetic breakers have been developed by several manufacturers for 4,160- and 13,800-volt ratings. Important developments have been made in flame retardant and nontracking insulations for use in medium-voltage magnetic circuit breaker equipments. Isolated phase bus designs now include ratings of 11,000 amperes self-cooled and 14,000 amperes forced-cooled for use with the bigger generators now being built.

Low-voltage circuit breaker developments include new stored-energy closing mechanisms for both manually and electrically operated designs which increase both safety and breaker life.

Product developments in the field of power switching equipment include further improvements in vacuum switches for high-voltage capacitor switching. In addition, stored-energy mechanisms are now available for interrupter switches to insure safe closing on faulted circuits.

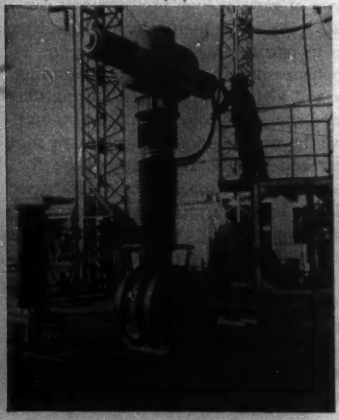
TRANSFORMERS

DURING 1958, a Pyranol-cooled load-tap-changing indoor transformer was announced by Canadian General Electric. This equipment combines the efficiency and compactness obtained with liquid cooling, the safety features and higher voltage characteristics of Pyranol, and the on-load tap-changing principles of the air-cooled transformer.

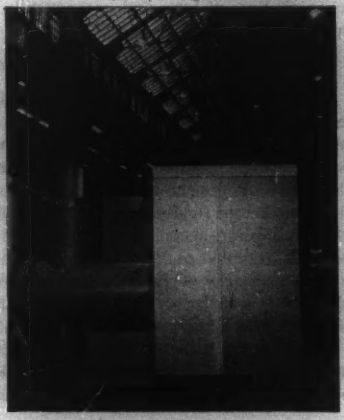
Westinghouse shipped its first inner-cooled transformer to New York Electric and Gas Company in 1958. This OA/FOA unit is rated 30,000/50,000 kva, 550 BIL. Inner cooling of power transformers represents a major advance in transformer insulation. Advantage is taken of the high dielectric strength of cellulose materials by eliminating oil from areas of high stress. Vertically mounted shell-form coils are arranged to have internal cooling ducts located in areas of low voltage stress. Reductions in weights and dimensions are obtained along with improved dielectric properties, cooling characteristics, and other improvements. This permits shipment of much larger kva and high-voltage units.

The phase isolated load tap changing transformer developed by the Pennsylvania Transformer Division of the McGraw-Edison Company has 3-phase transformation with individual single-phase regulation. Each phase has a separate load tap changing mechanism and its own self-contained oil-immersed switch for bypassing, disconnecting, and grounding, thus permitting safe

Courtesy General Electric Company



Courtesy Westinghouse Electric Corporation



◄ One pole of 115-kv 10,000-mva air-blast circuit breaker being prepared for short-circuit interruption tests. (*Right*) SF_6-filled 230-kv 15,000-mva single-pole unit prototype circuit breaker.

Courtesy General Electric Company

Steel hood lined with sound-absorbing glass-fiber batts completely surrounds 70,000-kva power transformer, one of five recently installed at Consolidated Edison Company's Queensbridge substation in New York City. Special design cuts sound level to 30 db below standard, a reduction of more than 99% in sound energy.

inspection and maintenance of the mechanism of one or all phases without interruption of 3-phase power supply to the load.

Five big GE power transformers installed during 1958 at Con. Ed's Queenbridge substation in New York City have sound levels almost as low as that of pole-type distribution transformers. The new aphonic enclosures were used to reduce the audio sound energy to less than 1% of the original energy. The five identical 70,000-kva units tested less than 50 db, a reduction of 30 db from the 80-db standard noise level for transformers of this size set by the National Electrical Manufacturers Association.

A new core developed for distribution transformers by Moloney Electric Company has led to improvements in performance and weight. It has every air gap staggered and bridged to provide a low reluctance path for magnetic lines of force and, consequently, the exciting current is reduced.

TRANSMISSION AND DISTRIBUTION

THE EXPLOSIVE GROWTH in the production and utilization of electric energy was underlined during 1958 by increased activity in research for technical knowledge on higher extrahigh-voltage transmission levels than those in present use. One such activity involved the design, construction, and operation of a complete a-c transmission system which will carry power and voltages from 460 to 750 kv. Data obtained from this prototype system of future extrahigh-voltage systems will be integrated with analytical studies, model investigations, and laboratory research.

In another area, in anticipation of the utility industry's need for pole-mounted capacitor banks containing fewer and larger units, more economical and convenient to install, a line of 100-kvar capacitor units has been developed comprising all of the standard voltage ratings in the 5- and 8.67-kv insulation class. It is anticipated that these 100-kvar units will also be useful in the larger high-voltage stack type assemblies.

In the field of distribution, there was specific interest in the developments on matters of aerial vs underground for residential areas, grounding problems in connection with the use of plastic pipe, the use of computers in transformer load management, and practice and experience in the shielding of distribution circuits.

In the field of towers, poles, and conductors, activity centered on broken-wire assumptions in tower design, the construction of transmission lines in urban and suburban areas on restricted rights of way, the use of both wood and steel for extrahigh-voltage lines above 230 kv, and the phenomena of conductor vibration including the development of instrumentation and devices for the purpose of measurement and analysis.

Considerable progress was made also on other system phenomena, such as switching surges, arc deionization times, corona and radio interference on high-voltage transmission lines, system stability, the fundamental basis for the insulation of transmission lines, and the abnormal frequency of flashover by lightning of high-voltage lines.

Science and Electronics

ELECTRICAL INSULATION

ADVANCES in the development and understanding of insulating materials become of increasing importance as they are incorporated in the design of new or improved electric equipment. Emphasis on the basic theory of electrical properties and breakdown in gases has led, for example, to new power transformers, such as the 10,000-kva 69-kv gas insulated transformer made by GE for the Pennsylvania Power and Light Company. Laboratory activity on liquid insulating materials also is expanding. The theoretical relationships between breakdown of gases at high pressures and conduction in insulating liquids at high field strengths has been looked into in particular.

The demand is increasing for electrical insulation to operate at higher and higher temperatures. During the past year, insulation systems for operation at 500 C and even higher have been announced, particularly for small transformers and recently by Westinghouse for small motors. Such ultrahigh temperatures call for new concepts in insulating materials such as ceramic-coated wire with an oxidation-resistant sheath. So far, such high temperatures are limited primarily to special military airborne equipment.

However, the trend to Class B (130 C) temperatures is continuing. Heat-resistant insulating varnishes have been announced by several companies for use, particularly with polyester wire enamels at Class B and even Class F (155 C) temperatures. Evaluation of the ther-

mal stability of insulating materials continues as an important activity of the AIEE Insulation Committee to provide the methods needed for temperature classification.

Insulating materials in new or improved forms provide answers to difficult manufacturing as well as engineering problems. The nonflaking, uniform surface and edges of GE micamat segment insulation made possible a new, automated production by the Ford Motor Company of commutators for use in automobile generators and starters.

Because the use of insulating materials is important to so many types of electric equipment, the first national conference on the Application of Electrical Insulation was sponsored jointly by AIEE and the National Electrical Manufacturers Association. The 3-day meeting in Cleveland, Ohio, was attended by over 1,450 people interested in almost every aspect of electrical insulation.

ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

A STUDY of intraluminal pressure fluctuations within the gastrointestinal tract provides valuable information on the smooth muscular activity of the esophagus, stomach, and intestines. Methods which have been used to detect and record these intraluminal pressures require the passage of tubes through the nose, mouth, anus, or artificial orifice. Such methods possess inherent defects which have prevented thorough study of small intestinal and colonic motility.

The need for a tubeless method for recording some parameter of gastrointestinal motility led to discussions with Dr. V. K. Zworykin, of the Medical Electronics Center of the Rockefeller Institute for Medical Research and the Radio Corporation of America (RCA). As a result of these conferences, an ingestible, pressure-sensitive radiotelemetering capsule has been developed which permits permanent recording of intraluminal pressures of the stomach, small intestine, and colon without connecting wires or tubes. The capsule is a rigid plastic cylinder 3.0 centimeters long and 1.0 centimeter in diameter. A pressure transducer, comprising a flexible diaphragm and a variable reluctance magnetic circuit, frequency modulates a transistor oscillator in response to pressure variations. Electromagnetic coupling between this magnetic circuit and external pick-up coil or antenna communicates the signal to a sensitive FM receiver whose output is in turn recorded oscilloscopically and on paper. Power for the oscillator is supplied by a 1.2-volt rechargeable cadmium cell, which has a "life" of approximately 24 hours. The entire capsule comprises only seven components: the variable inductor, a transistor, two capacitors, two resistors, and the battery.

The capsule has been swallowed without difficulty 52 times by 48 subjects and has passed through the gastrointestinal tract without causing any subjective sensation. Gastric, small intestinal, and colonic pressures have been recorded and the wave forms observed correspond in frequency and general appearance with those recorded by other methods.

The method possesses the following advantages: (1) the capsule responds accurately to frequencies above 10 cycles, thus preserving all physiologically significant pressure data, (2) it causes no discomfort to the patient, and (3) it permits prolonged recording of intraluminal pressures in previously almost inaccessible areas such as the distal small intestine and colon. Thus, the method offers particular advantages for the study of functional disorders of the small and large bowel.

ELECTRONICS

THE PAST YEAR has brought increased development of infrared detection devices for communications and for active and passive search. Accurate missile position data in the first instants of flight being crucial, infrared passive tracking devices are locked on at a point of fixed temperature in the exhaust, thus giving accurate position data until cloud cover intervenes. This is a significant advance, because ground clutter and inability to distinguish between missile parts rendered radar unsatisfactory and propulsion unit smoke obscured visual or photographic tracking. This development may later be used in tracking nose cones re-entering the atmosphere.

Widespread effort applied toward increased reliability has resulted in expanding interest in tutorial papers, basic concepts, and new testing equipment. Some of the new testing devices are quite sophisticated; one continuity checker programs itself when connected to a correctly wired unit of the type to be tested.

The familiar vacuum tube electrode structure is available now in an envelope called the "match-box." All leads are locked in the same plane, allowing better spacing between input and output leads and greatly increased resistance to shock and vibration. The design is particularly applicable to printed circuit use and allows mechanized feeding into position on the printed circuit board or chassis.

The tenth anniversary year of the transistor has been one of continuing research into solid-state phenomena and development of new devices. This activity has, of course, resulted in improvements and extensions of theory. Considerable effort is being applied to the area of compound semiconductors among which the most promising at present are gallium arsenide and indium phosphide.

The feature of high reliability, with reduced size and power requirements, has resulted in using transistors in critical nuclear counting devices and in power-line carrier systems. A commercial receiver now uses transistors at 17.8 mc.

The low dissipation at cutoff and saturation has spurred development of switch applications including one unit handling 5 amperes at 200 volts with only 5 watts dissipation. This same property is utilized in a pulse duration system giving essentially Class A performance at output levels several times larger than those obtained in the usual Class A circuits.

MAGNETIC AMPLIFIERS

IN THE MAGNETIC AMPLIFIER FIELD during 1958, outstanding engineering progress was achieved in the development of new circuitry combining magnetic amplifier and controlled semiconductor devices. The introduction of the controlled rectifier (p-n-p-n semiconductor device) gave great impetus to this development because of its potential as a small lightweight replacement for bulky magnetic power output amplifier stages. However, the major progress was in the field of magnetic amplifier transistor combinations. Applications of these new circuits were made in a wide variety of equipments for both industrial and military jobs. Some examples are as follows:

1. Regulated power supplies using the efficient power handling capabilities of magnetic amplifiers for rough regulation and the rapid response of transistors in linear operation to achieve a maximum of power handling capability and fast response regulation.

2. Rapid response, high-gain d-c amplifiers for instrumentation control and computing applications. Using high-frequency magnetic amplifiers, supplied by transistor saturable-core oscillators, higher gain and stability usually can be obtained with fewer components than can be obtained with transistors alone.

3. Miniaturized and highly efficient linear power amplifiers using small high-performance magnetic amplifiers to control either transistor or controlled rectifier output stages. Here the isolation and stability features of the magnetic amplifier are retained while power output per unit volume and weight are increased manyfold.

4. Static inverters for converting d-c to a-c or d-c to higher voltage d-c. Inverters, using saturating magnetic cores to switch transistors and magnetic amplifiers for voltage regulation, are now being used to supply a-c power from battery sources in many missile, aircraft, marine, ordnance, and industrial applications.

5. Static, sensitive relays or instrument-type bistable amplifier devices which combine the input isolation and stability features of the magnetic amplifier with the rapid response and power-handling capabilities of transistors operating in the switching mode. Sensitivities of the order of millimicrowatts were reported for devices having the ruggedness and reliability typical of static equipment.

The capability of magnetic amplifiers to operate at high ambient temperatures was developed further during the year. Magnetic amplifier reactor assemblies suitable for operation in 200 to 250 C ambients were produced in quantity. Development work on 500 to 600 C magnetic amplifiers was carried on under military sponsorship.

In addition to the outstanding new developments, more conventional magnetic amplifiers continued to be applied at a steadily increasing rate. In power generation and distribution systems, as well as in the steel and paper mill control field, magnetic amplifier regulators are being widely used. With the increased use of silicon diodes instead of ignitrons for high-power rectification, there has been an associated increase in the use of high-power magnetic amplifiers with ratings in the hundreds of kilowatts for control and regulation of these rectifiers. Industrial use of static switching equipment using magnetic logic amplifiers also increased during the year.

NUCLEONICS

THE EXPERIMENTAL BOILING WATER REACTOR plant, located at Argonne National Laboratory, has accumulated 24,361,000 kwh of operation as of September 25, 1958. The principal operating difficulties encountered in plant operation have been non-nuclear in nature and consist primarily of malfunction of the air ejector and a turbine blade failure. The plant was designed to produce 20,000 kw thermal (5,000 kw electrical). The reactor power level was successfully increased in March 1958 without reactor modification to 61,700 kw. The plant will be modified in 1959 by adding enriched fuel and a larger heat sink so that 100,000-kw thermal operation can be demonstrated.

This experimental plant has successfully demonstrated (1) that the boiling water reactor is a reliable means of generating electric power, (2) that many of the anticipated problems have failed to materialize, and (3) that increased specific power can be achieved and will reduce power generating cost significantly.

A number of newsworthy events have taken place in the field of atomic-powered submarines. The *USS Skipjack*, first nuclear submarine designed from the keel up for maximum underwater performance, was launched in May at the shipyard of the General Dynamics Corporation's Electric Boat Division.

The USS Sargo, commissioned on October 1, 1958, is the fourth submarine powered by a nuclear reactor plant designed and developed by Westinghouse under the direction of the Naval Reactors Branch, U. S. Atomic Energy Commission. A sister ship of the Skate, the Sargo is 257 feet long with displacement of about 2,000 tons. It is the first atomic submarine to be built on the Pacific Coast.

In September, the *Swordfish* was commissioned at Portsmouth, N. H. It is the second in a series of 257-foot twin-screw attack submarines. A sister ship, the *Sargo*, was commissioned in October at the Mare Island Naval Shipyard, Vallejo, Calif.

The *Nautilus* made news with its historic underwater crossing of the North Pole. The 1,980-mile underwater crossing of the icecap took 96 hours, from Point Barrow, Alaska, on August 1, to a point between Greenland and Spitzbergen on August 5. Eight days after the *Nautilus*' crossing, the *Skate*, the United States' third nuclear-powered submarine, duplicated the trip under the North Pole. On its return from Portland, England, to New York, the *Nautilus* set a new submerged transatlantic crossing record of 6½ days. Westinghouse designed and developed the nuclear reactors for all of these submarines for the Naval Reactors Branch of the Atomic Energy Commission.

SEMICONDUCTOR–METALLIC RECTIFIERS

THE SEMICONDUCTOR ART continues to expand at a tremendous rate and new devices are being developed continually. This year semiconductor switching devices are in the forefront.

Controlled rectifiers capable of performing all the functions of magnetic amplifiers and thyratrons are now commercially available and designers are applying them to all types of circuitry.

Switching devices going under the names of dynistors and trinistors are being used in preference to transistors in power amplifiers with a corresponding increase in power-handling capabilities.

Transistors capable of handling much larger blocks of power became available, resulting in stimulating the revamping of a large number of control applications and their circuitry.

Semiconductor inverters, that is, devices to convert d-c to a-c, are being introduced with power ratings up to 500 watts. As larger switching semiconductor devices become available, these inverters will also increase in rating. Laboratory models with ratings above a kilowatt are already on test. These inverters have found a ready application in automobile radios, where they are replacing mechanical vibrators.

In the medium-power rectifier field, regulated power supplies using semiconductors to control as well as supply the required d-c power are finding applications as power sources to energize electronic computers.

In the large-power rectifier field of 1,000 kw and over, germanium and silicon type semiconductor rectifiers continue to be applied. New developments to improve designs, increase reliability, and simplify current balance between the rectifier cells have been worked out and applied to commercial equipment.

Manufacturers of power semiconductor rectifier equipment introduced silicon rectifying devices in place of germanium in all available equipment ratings. This included high-current electroplating supplies rated 6 and 12 volts as well as equipment rated 350 volts and higher for electrochemical processes such as chlorine and aluminum production. Key factors attributing to this shift were the higher permissible operating temperatures of silicon cells, which makes them less critical with respect to the temperature of cooling media, and the introduction of silicon having a higher purity than heretofore available, which meant that the cell manufacturers could provide cells having higher blocking voltage ratings and lower losses.

An outstanding example of a large silicon rectifier equipment for electrochemical service is an installation of four rectifier units, each rated 12,000 amperes at 350 volts, which supplies power for producing chlorine in a plant at Niagara Falls, N.Y. The equipment was purchased as a result of the 25- to 60-cycle changeover program in that area.

Silicon rectifiers for general industrial service were introduced in 1958. These equipments, rated 75 to 1,500 kw, 250 volts d-c, can safely withstand repeated overloads and short circuits and have the same overload rating (125% for 2 hours, 200% for 1 minute) as mercury-arc rectifiers and motor–generator sets. In sizes rated 250 kw and above they are being built as d-c unit substations for primary voltages up to 13.8 kv. The simplicity of the silicon rectifier makes it extremely attractive for this class of service.

SOLID-STATE DEVICES

THIS YEAR three different areas of technology are represented in significant solid-state device developments. These are the fields of radar technology with the maser and the parametric amplifier, the transistor device field with the switch transistor and silicon power transistor, and a rejuvenated field of thermoelectricity with Peltier refrigeration devices.

The maser is a crystal in a waveguide which has energy levels occupied by charges in a nonequilibrium condition brought about by a local source of microwave energy. These levels can be stimulated to re-emission of energy by incoming radar signals from a distant source. Gain is obtained from the system and noise level is very low. Major development work has been carried out by the Bell Telephone Laboratories.

It has been known for many years that a radio-frequency mixer system with power gain can be made utilizing a periodically varying capacitor. Bell Telephone Laboratories have given this principle a new embodiment by using silicon crystal rectifiers as the capacitive element.

Both GE and Westinghouse have developed transistor-like devices which act as thyratrons. The device has a high impedance with applied voltage until a voltage is reached that causes the device to go into a low-impedance state. The transition point is controlled with a third electrode. These "controlled rectifiers" are related to Shockley 4-layer diodes, but are constructed to control much larger blocks of power.

The trend of new developments toward static solid-state devices continues with increasing pace.

Utilization of Engineering Talent

H. R. HUNTLEY
FELLOW AIEE

The biggest single factor in the economic health of an enterprise, in the author's opinion, is the quality of work its engineers do today and every day. Thus, one of the most important problems industry must face is that of utilizing engineering talent effectively.

IT MAKES ME very happy to have the opportunity to participate in this discussion because I happen to be associated with an enterprise the economic well-being of which—and its contribution to the well-being of the country—depends to a very large extent on the quality of its engineering and, hence, on how effectively it utilizes the abilities of its engineers.

This problem is not new with us; in fact, we have had to struggle with it ever since Alexander Graham Bell invented the telephone and, I expect, we will be struggling with it as long as private enterprise exists. So while I am glad to see that things like sputniks and the Space Age have focused a great deal of attention on science and technology—and have made the people who practice them not only tolerated but even respectable—I sincerely hope that the current flurry does not cause us to forget the long-term nature of the problem and that we don't so exhaust ourselves in crash programs and talk that when the pressure drops a little a reaction sets in which makes the situation worse than it was before.

In my own mind, the problem of getting the highest quality engineering job can be considered in the following four main categories, which I shall discuss in turn:

1. Matching men and jobs.
2. Letting engineers do engineering.
3. Converting college graduates into engineers.
4. Circumventing Parkinson's Law.

But, since there is no sense in talking about making effective use of engineering talent without being sure we know what talents we are talking about, I must first say a few words about our concept of engineering and its objectives.

ENGINEERING IN THE BELL SYSTEM

THE BELL SYSTEM (which includes operating companies, AT&T Company, Bell Telephone Laboratories, and Western Electric Company) has several tens of thousands of engineers and scientists and aside from some military work which I will not discuss, their talents are devoted to one end: the construction of a communications plant, and the utilization of that plant, in such a way that as long as private enterprise endures it will produce *simultaneously* (a) service which the people think is superlative in quantity, quality, and kind, and which they think is a bargain, and (b) maximum difference between income and outgo per dollar invested.

Constructing this plant is not a one-shot job; it goes on year after year as people's wants and needs grow in size and change in scope and character, and as science provides basic advances which permit these growing and changing wants and needs to be met in better and more economical ways. It requires the investment of large sums of money every year. It is engineers who actually invest this money and who, in company with many other parts of the organization, must see to it that the plant they buy is utilized effectively.

These engineers are currently investing money at a rate of over $2 billion per year (over $8 million per working day) and, give or take a few hundred millions, it looks as if they will be doing this for many years to come. With few and unimportant exceptions, every dollar they invest is sunk irretrievably; it cannot be "uninvested," because it is spent for things which are of no use to anybody but us and which, therefore, cannot be sold. In other words, every dollar invested carries the requirement that it earn its keep regardless of whether it is invested in the wrong or in the right type and amount of plant. This requirement cannot be terminated by any such simple process as discontinuing the use of the plant or even taking it out. At the rate of a couple of billion dollars or more a year, it does not take long to pile up quite a tidy investment which must be earned on; in fact, the wisdom with which every one of these dollars is invested is the single biggest factor in how healthy the enterprise will be tomorrow and 10, 20, or 30 or more years in the future.

All of this adds up to the simple fact that what we really ask our engineers to do is to invest huge sums of money in such a way as to do not only today's job superlatively, but also the best possible job in the future. This, of course, requires that every dollar invested be invested in the framework of long-range plans.

But long-range planning does not consist of preparing a neat set of packages which spell out precisely what quantities and kinds of service people will want and what instrumentalities will be used to supply them *x* years hence. The fact is quite the reverse; the basis for long-range planning is change—change in people's wants and needs and change in science and technology—which cannot be predicted with precision.

A special article based on talks before conferences on utilization of scientists, engineers, and technicians at Omaha, Nebr., and Milwaukee, Wis. Recommended for publication by the AIEE Management Committee.

H. R. Huntley is chief engineer, American Telephone & Telegraph Company, New York, N. Y.

One can get a good idea of the rapidity and unpredictability of these changes if he compares the detailed prognostications which were made at the beginning of any 20- or even 10-year period with the facts at the end of this period; he will find that any resemblance between them approaches, as they say in the movies, being "purely coincidental." And there is no doubt in my mind that in the next 10 or 20 years we are going to see more changes both in the want and need area and in the scientific and technological area than in the last 10 or 20 years.

Thus, the real problem that engineers are faced with is how to plan today and every day to meet unknown future needs with instrumentalities which can be known only in general terms. The only way I know to do it is to rely on those characteristics which differentiate men from machines, among them being ability to understand technical and economic trends, imagination, flexibility of mind, that nebulous thing called judgment, and the courage to do what judgment says should be done.

These abilities permit the engineer to be master of the future even if he cannot know what the future will be. He does this by knowing what direction he wants to go in and what steps to take to go in that direction. He never expects to reach a destination, because he knows that if ever a time comes when he does not see the future stretching out beyond his comprehension, he ceases to be an engineer. However, he also must have enough flexibility so that he can change direction at any time that changes in science or people's needs and wants tell him he should. He knows, too, that he can have a profound effect on what the future will be, and that he can shape it significantly by wedding science to wants and needs.

This concept of planning for an unknown future but simultaneously shaping the future to meet one's plans is so important that I want to say a bit more about it because, in my opinion, it is the hallmark of the engineer. Actually, the process is very much like the one by which the human race and animals and plants are perpetuated and—hopefully at least—improved; it works somewhat like this:

Research keeps pushing back the frontiers of knowledge by developing new concepts, new materials, and new potentialities in the use of nature, from which new and useful things can be developed. Research people can and should recognize that needs and wants exist in order to give some direction to their efforts. But, they must be kept free from the direct pressure of needs and wants or they will become simply inventors and designers of gadgets.

At the same time, needs and wants keep changing as people's ideas and the demands of business and industry grow and change. People need to take account of the actualities and potentialities of science and technology, or they will merely be wishing for pie in the sky. However, people must not be constrained to want only what is available or what they can clearly see, or else there would be no market for those new products which science and technology would make possible.

Thus, research moves ahead, and wants and needs move ahead more or less independently—or at least with only indirect ties between them. Only by mating them at appropriate intervals and under appropriate circumstances can we take full advantage of the progress in science to satisfy new wants and needs.

This, then, is what we conceive to be engineering, and when I talk about utilizing engineering talent, I am talking about those talents which engineers must use to work effectively in this kind of atmosphere.

I am now in a position to talk about the four concrete phases of the problem of how to use engineering talent to get the engineering job done most effectively.

MATCHING MEN AND JOBS

I TAKE IT as axiomatic that effective utilization of talent rests on this foundation: Every man must at all times be (1) producing the best and most useful work which his capabilities permit and (2) growing in capability as rapidly as possible.

Now in any sizable organization, there are many different kinds of jobs and many different kinds of people. Both the jobs and the people grow and change. Because different kinds of people do best on different kinds of jobs, we cannot make maximum use of people's talents unless we match men and jobs carefully and keep them matched as both grow and change.

The correct matching of people and jobs will not come about automatically; it calls for continual application of management skill of the highest order. Except in unusual cases, people do not automatically drift into the right slots. In fact, most of them wouldn't know what slot they should be in even if they had a free choice. But only if they are in the right slots can they use their talents effectively and grow in capability rapidly.

The task is further complicated by the fact that neither jobs nor people can be divided into neat little classifications so that all one has to do is to match one against another. The range of human characteristics is so wide and these characteristics are combined in such a wide variety of ways in different people that nobody as yet has been able to set down specifically those characteristics which describe how a particular person would fit a particular job. In addition, engineering and technology are so complex and change so rapidly that no really good way has yet been found to describe particular jobs. But complicated or not, it must be done.

It is quite easy to spot people and jobs who are at the extremes of the distributions; this man obviously will do his best work as a lone wolf in a laboratory and that man will be best as a leader of people. However, the proportion of all of the people who can be so labeled, at least early in their career, is very small.

There are two basic kinds of considerations that need to be taken into account: (1) In what part of the organization, and in what kind of work within that part, will he produce best and grow fastest at each particular stage of his career? (2) Will he contribute most and

grow fastest if he follows the route which involves supervising and directing larger and larger groups of people or will he do better as a professional or a technical expert?

It doesn't help too much to try to distribute people on the basis of total mental ability—even if there were a method of measuring it. In a well-organized and well-managed organization, each part needs and must make as much use of ability as any other part. The distribution must then be made not on the total abilities of people, but rather on the different kinds of abilities possessed by each of them. For example, in the Bell System it takes as much imagination and creative ability to be a good operating company engineer as to be a good research scientist, but these characteristics are of a different kind and must be able to operate with different objectives and in a different atmosphere. Likewise, the fact that one man loves supervisory work and another loathes it, does not indicate a difference in ability; it simply indicates ability of a different kind.

I do not know any pat solution to this perplexing and important problem, but I do think I know the ingredients of which it must be composed. They consist primarily of

1. An atmosphere created by top management which insists that every engineer in the shop can produce more and better work than he is producing (or even than he thinks he is capable of) and that all that is needed to bring out this ability is to get him in the right place under the right leadership.
2. Selection and education of supervisors who believe, and practice, the same thing.
3. Recognition of the fact that nobody can be sure in advance how well a man will produce in a particular spot and a willingness to learn by trial and error and to take some chances.

This is not an easy prescription, and I am afraid I have laid a rather tough problem in the laps of management; but that is where it belongs.

LETTING ENGINEERS DO ENGINEERING

EVEN IF we have done a pretty good job of matching men and jobs, we can still lose a lot of effectiveness if our operations are not so managed that we let engineers spend their time doing engineering instead of frittering it away on non-engineering matters. This has been the subject of more papers and speeches than almost any other subject in the whole field; in fact, I feel that I may be carrying coals to Newcastle in talking about this subject at all.

However, in much of the literature and talk with which I have come in contact, the inference seems to be that the solution to the whole problem resides solely in providing sufficient technicians, clerical help, mechanization, etc., to do the non-engineering types of work which always go along with an engineering job. I feel, however, that this is only part of the problem, and probably not the most important part. In fact, without looking at the problem much more fundamentally, merely adding technicians, clerks, machines, etc., may compound rather than simplify it.

My thinking about this problem starts in the insistence that two basic questions be asked and answered:

1. What is engineering and what are its objectives?
2. What specific jobs should be done, in what order should they be done, and how much effort should be put by whom on each of them?

The answers to these questions obviously will be different in different organizations and at different times; no one answer is good for everybody or for all time. However, only when we have answered these questions can we effectively tackle the problem of how best to divide the work between engineers and non-engineers.

In answer to the first question—what engineering is and why—I have already said quite a lot about what we think engineering is in the Bell System so I won't belabor this matter further. However, I would like to emphasize the point that every organization must have a clear picture of what engineering is in that organization if it is to be able to differentiate clearly between engineering and non-engineering work.

Now let us tackle the question of what specific jobs should be done and how and in what order. I know of no solution to this problem except to be very hard-boiled in budgeting effort among the numerous things that it would be desirable to do. It is easy to say this, but it is hard to apply it because every job is important to somebody or it would never have been put on the list. The best way I know is to make every job stand up against the three age-old engineering questions:

1. Why do it at all?
2. Why do it now?
3. Why do it in this particular manner?

This type of test, if conducted conscientiously, will help greatly in separating the sheep from the goats and getting the sheep lined up in the proper order. The right jobs will come through with flying colors; the unimportant jobs will drop off the end. In addition, we must make up our minds to handle big jobs in a big way and little jobs in a little way. When we have done these things, we are in a position to divide our work into engineering and non-engineering categories and to relegate much of the work which engineers are often called upon to do to non-engineers or machines.

I will be the first to admit that there is a large "gray area" between what is unequivocally engineering and what is unequivocally not engineering, and that I do not know any precise way of dividing up this area. But I have used the concept of the differentiation between machines and people to which I referred previously as a rough guide. That is, any operation which a computer or business machine could do is not engineering.

A machine has memory, it has logic, and it can perform computations with great speed and accuracy. What it cannot do, however, is to use these abilities or the results of its operations to generate new ideas or to formulate judgment.

I wish to make it clear that I do not believe one can draw a hard and fast line between engineering and non-engineering by this kind of a concept. All I am saying is that thinking about the differences between people and machines can sometimes help in getting down to fundamentals. It is particularly important to get down to fundamentals in these days when, on the one hand, everybody and his brother seem to want to be called "engineer," and, on the other, there is a lot of pressure to define an engineer on the basis of his education or his previous experience, etc., rather than on the basis of performance.

SHORTENING THE CONVERSION INTERVAL

IN ORDER TO MATCH men and jobs and to let engineers do engineering, it is necessary to have the engineers in the first place. And, in order for business and industry to have engineers, it has to make them out of raw material.

These days, the major sources of raw material from which we make engineers are the colleges and universities. Of course, they are not the only sources of material from which engineers are made; some of the best engineers I know made the grade sans cap and gown. But this discussion will be confined to the problem of converting the college graduate into an engineer.

We have a double-barreled problem: the colleges should turn out the best practicable raw material, and industry should turn this raw material into the highest possible quality engineers in the shortest practicable time.

Since I am in industry, I will follow the usual course and look at the college side of the problem first. Let me hasten to say, however that I do not want to create the impression that I think the colleges are not doing a good job; the young graduates I come in contact with are a pretty competent bunch and I feel pretty sure that they got that way because of, rather than in spite of, their education. But as in the engineering job itself, I am sure that educators always see a future which can be defined only in terms of constant improvement, and that they are no more satisfied with the job they are doing than engineers are satisfied with the job they are doing. It is with this thought that I make bold to offer a few suggestions to educators which may be helpful.

Based on my observations and discussions with as many younger engineers as I have been able to talk with recently, there are several hurdles which industry must overcome and which the colleges could do something about.

First of all, one of the biggest and most important things that a new graduate has to learn is that his every action and decision affects the success of the business; it comes as a shock to many of them when they learn how much hangs on what they do and say in the normal course of their work. In fact, one of the signs by which a man can tell that he is about to become an engineer is the first time he has butterflies in the stomach because he suddenly realizes that what he did that day has committed his company irretrievably to a project or a line of action which will profoundly affect its future economic life.

Second, most (but not all) of these young engineers had to learn after they finished college that the main benefit they had derived from their college education was knowledge of principles and increased ability to think; the specific things they learned in college were of relatively much less use to them.

In addition, many of these youngsters had quite a bit of difficulty in learning that engineering consists at least as importantly of finding what problems to solve as it does in finding solutions.

Furthermore, they had developed too great a reliance on the written word. They had come to believe that if it is in a book it must be so, and there must be a book somewhere that has the answer to any problem.

Finally, they had come to feel that an answer to a problem must be either right or wrong; in fact, their grades were in many cases dependent on whether they got the right or wrong answer. The happier ones among the people I have talked to were those who had been fortunate enough to have teachers who were as much interested in the "why" of what they were teaching as in the "how." Their only regret was that in most cases this happy experience did not occur early in their college careers.

Now while these things are the most important, there are some other things that would make the conversion process easier. For example, it would help if graduates knew fundamentals, such as Ohm's Law and the conservation of energy, intimately enough that they could think through problems which were a little unusual—or at least check them for reasonableness—instead of trying to apply some vaguely remembered formulas. It also would be helpful if they knew something about the economics of investing in things which cannot be sold or moved.

Now lest I appear to be too hard on the educators, let me hasten to say that we in industry are far from being above reproach. From what I know and read and hear, I gather that many industries have "induction" or "training" programs for engineering graduates and these programs cover a very wide range. However, from these same sources I gather also that very few, if any, of these industries are really satisfied that their programs are as effective as they would wish.

I will confess to being a bit of a doubting Thomas as to whether this matter of formal programs is not overdone in many cases. On the other hand, I am not against formal programs as such, but I think they need to be examined very carefully to be sure that they do, in fact, cause the graduates to come to the realization of the nature and responsibilities of engineering at an earlier date than if they were simply put to work. And I am quite sure that simply moving a man around from job to job or department to department in a haphazard manner in the hopes that enough knowledge will rub off on him to make him an engineer is not adequate.

Although I have no pat formula, there are some things that I feel quite sure are essential, formal program or no. I think we should make the graduate work—and work hard—from the first day he comes on the job. No graduate is going to have any respect for us or our business if all he does when he gets into it is watch other people work, or loaf.

His work should be useful. If we cannot achieve this objective by shifting him around from one department to another, we should give him definite and difficult responsibilities in one department which should involve contacts with other parts of the business.

At the earliest possible moment, we should give him jobs which test his ability to think and are beyond what we and he think his capabilities are. No man ever develops if all he has to do are things that he is fully capable of doing.

We must be sure he always has a boss who avoids like the plague stultifying his creative urge by forcing his thinking into established channels.

Finally, we must not move him so fast that all he gets is a kaleidoscopic picture and never has time to evaluate the fruits or (miscarriages) of his labors.

However, in doing these things we must guard against overdoing them; we must maintain a delicate balance between keeping him on his mettle and discouraging him by the magnitude and complexity of the over-all job. We must keep in mind that no one process will apply to all of them, because while these youngsters are not yet engineers they are human beings, having the wide range of characteristics which human beings display.

These things are, as I see them, the main jobs of educators and industry. But, as I said before, we should be able to do a better job if we work closely together. More specifically, I suggest that industry promote by whatever means are appropriate a greater knowledge on the part of educators of what goes on in industry. The objective is not for the educators to teach what goes on but to help them better prepare the student for his experience when he gets into industry.

In addition, educators should promote more participation by industry in lectures, seminars, etc.—again to help the students prepare for the period of transition they will have to go through when they graduate.

CIRCUMVENTING PARKINSON'S LAW

ALL OF THE PROBLEMS I have been talking about—matching men and jobs, letting engineers do engineering, converting college graduates into engineers—grow more complex and difficult as business and industry grow larger and become more complex.

Now this growth in size and complexity of business and industry is inherent as the population grows, and as people's wants and needs grow and as science provides the basis for new and better ways to meet these wants and needs. It is inherent that growth in size and complexity of business and industry requires that we have more engineers and scientists and that we spend more money for buildings and laboratories and all of the rest of the trappings that go with more engineers and scientists.

But the mere spending of money and the mere having of more engineers and scientists do not guarantee that the quality and quantity of work performed will grow proportionally. There may merely be more time available for engineers to do unimportant things or to work on non-engineering matters or to attend conferences, etc. In short, merely adding people simply may give more room for inefficiency. If we are to use engineering talent effectively, we cannot tolerate inefficiency from any cause, much less from frictional losses resulting from organization size and complexity.

This problem of gearing growth in size and structure of staff and administrative organization to growth in basic need is not unique to engineering; it applies to the whole enterprise and I think it is one of the toughest problems management has to face.

The only phase of this problem which is peculiar to engineering is the tendency (which I deplore) among both engineers and non-engineers to think of engineering as being somehow radically different, and apart from other parts of the enterprise and, hence, posing a different organization problem. This just is not so The engineering organization makes its unique contribution to the whole enterprise in precisely the same way as any other part of the organization and it has the same problems of size, structure, and co-ordination with other organizations as do any other part. The sooner we get away from the concept that engineers form a group distinct from other management groups, the better off we will be.

I suppose that every one of us who has a direct interest in organization has recognized this basic problem—some of us as a problem applying to some other organization and one that somebody ought to do something about, and others of us as a problem that is so critical that we ourselves ought to do something about it. All of us probably can use some guideposts to tell us whether we are approaching the critical stage and what we might do about it before we get there. And here is where I have found Parkinson's Law to be very helpful. It is a delightful satire and was written to apply to an entirely different situation than we face here but it can provide guideposts which we can use to help us in our thinking.

You probably know that Parkinson's Law is based on the known fact that work expands to fill time available for its completion and that, as a result, there are never enough people in an organization to perform all of the visible tasks. The law itself states that the size of an administrative organization (he was writing about organizations in the British Government) grows at a constant geometric rate of around 6% per year regardless of whether the amount of real work to be done increases, diminishes, or even vanishes.

Parkinson himself is content to state the problem leaving its solution to others. We are the "others" who must solve it. And I think we can define some of the

guideposts which will tell us whether or not we are, in fact, solving it.

Here are some of the indications that we are *not* circumventing the law:

1. When we change our organization setup to gain efficiency and end up with more people than the number with which we started.

2. When we have so much difficulty in co-ordination between groups that we require a plethora of routines and rules and consequently think we must standardize everything, including thinking.

3. When one group has labored long and diligently on a problem only to find that, unknown to them, some other group has also labored long and diligently on the same or a closely allied problem. It is bad enough when both groups come up with the same answer; it can approach tragedy or comedy—depending one one's sense of humor—if they come up with different answers.

4. When it becomes almost impossible to set up a conference with less than 15 or 20 people in it and when these conferences degenerate into a series of speeches which take so much time and effort to prepare that they seriously eat into the time available for useful work. There is, of course, a time and place for this type of formal conference, but we must watch out that it doesn't become a way of business life.

5. When everything must be put into memoranda which take an inordinate amount of time to prepare and an inordinate amount of time to read, comment on, understand, and answer. Memoranda are necessary to record things of lasting importance but the danger occurs when they are used for things which could better be handled in face-to-face discussions but which cannot because of the complexity of the organization and the number of people concerned.

There are, of course, many other examples, but I think I have given enough to indicate what I mean.

I wish I had a solution that was foolproof but, again, all I have is a few ideas. Of course, the fundamental of the whole thing is to gear organization growth to growth in useful work rather than let work grow to organization. The best way I know to do this is to test every job in the manner I have indicated previously; that is, make it stand up to these tests:

Why do it at all?
Why do it now?
Why do it in this particular manner?

But there are a couple of other things dealing with organization which may be helpful. One of them is the organization setup itself. A soundly conceived organization plan which imposes minimum hurdles and promotes maximum co-ordination between groups helps a great deal. However, in a large and complex organization there is no setup which completely eliminates hurdles; all that can be done is to get the best practical compromise between many conflicting requirements. Proper organization provides good machinery to help solve the problem, but it is not a solution in itself. Parkinson's Law really goes to work when some one acts as if by having a good-looking organization chart he had solved the problem.

Thus, an important part of this job is how best to overcome the fact that no organization setup can be perfect. We have found in our business that in some cases the so-called "task force" or "project" approach helps a lot. The trick consists of giving a job to one or a *very few* well-qualified people with these kinds of instructions:

"Get it done come hell or high water."
"Work yourself out of the job as soon as possible."

This approach is particularly appropriate where a normal departmental approach would spread the job over so many different groups that it would be badly fragmented and each fragment would have to fight for priority individually. Under appropriate circumstances it works beautifully, but one must sternly resist the temptation to let it blossom into a new empire.

When all is said and done, however, these things are but mechanical tricks to implement the will to do. Without the will to do, and without being sure that everybody concerned knows and supports it, Parkinson's Law will keep right on operating.

CONCLUSIONS

ENGINEERING is always for the future, and in our organization (and I suspect in many others) the quality of the work the engineer does today and every day is the biggest single factor in the economic health of the enterprise, as long as it exists.

The engineer must plan for unknown future wants and needs with unknowable instrumentalities. To do this, he must have certain talents, chief among which are imagination, judgment, and guts, based on the solid foundation of technical and economic competence.

If we are to use these talents effectively—and the stakes are too great to do anything else—we must do several things:

1. We must match men and jobs so that at all times every man has the opportunity and the urge to produce beyond his capabilities and so that his capabilities grow as rapidly as possible.

2. We must find a way to let engineers do engineering instead of frittering away their time on non-engineering matters.

3. Educators and industry must individually and jointly work to the end that the colleges produce the best practicable raw material, and industry turns this raw material into the highest possible quality engineers in the shortest possible time.

4. We must circumvent Parkinson's Law.

I may have created the impression that I think this whole matter is a management problem of the first magnitude—but that is precisely what I intended.

Tramp-Iron Remover for Forage Harvester

F. C. JACOB J. B. DOBIE

NAILS, WIRE, AND OTHER TRAMP IRON in hay are likely to puncture the stomach of a cow if ingested. Pneumatic conveyors are often the only devices handling hay and conveying speeds of 8,000 feet per minute are common. A metal detector offers no obstruction to flow. Combined with a mechanical rejecting device it offers a means of tramp-iron removal at even the highest pneumatic conveyor speeds. A suitable combination has been described by J. B. Dobie, et al, in an article "Electronic Detection and Removal of Tramp Iron from Chopped Hay," which appeared in *Agricultural Engineering*, June, 1953, and by J. B. Dobie and F. C. Jacob in another article "Removing Tramp Iron from Chopped Hay," which appeared in *Electronics*, June 1954. This combination is for use with fixed installations such as barns or feedmills. The same method can be adapted to a field forage harvester to make a self-contained unit. However, the blower pipe is shorter, the hay delivery rate is more variable, the hay has variable moisture, the vibration environment is more severe, and the problem of disposal is more awkward for the field harvester as compared to a stationary machine. Appropriate design can accommodate these factors.

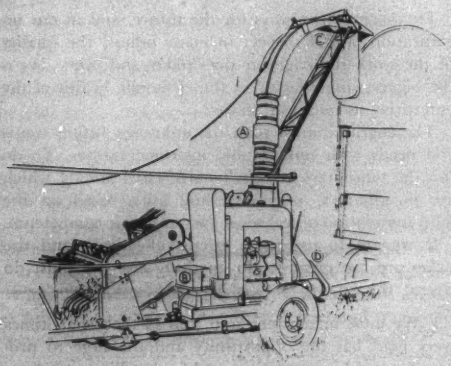


Fig. 1. Field forage harvester with tramp-iron remover showing inspection coil A, amplifier B, rejector C, and generator D.

The metal detector uses a steady magnetic field. Since this type of detector operates on a rate-of-change-of-flux principle, a high conveying speed is to its advantage and moisture has no effect. In Fig. 1, a pickup coil in the magnetic field (A) produces a signal if the field is disturbed by a tramp-iron object. The signal, amplified at (B), energizes a solenoid on the mechanical rejecting device (C). A small amount of hay is diverted into the bag along with the tramp iron. Power is supplied to the tramp-iron remover by the generator (D).

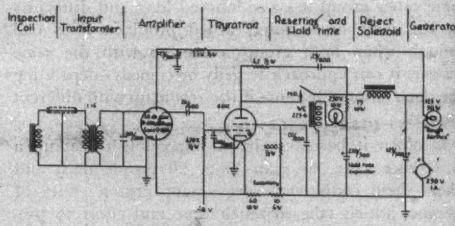


Fig. 2. Schematic diagram of the electrical system.

The tramp-iron transit time from the detector to the rejector is not constant. It depends, with other factors, upon whether the material is flung from the blower tip, in which case its speed can exceed that of the air, or whether it is slowed, for example, by pipe wall friction during its travel. The rejector must therefore dwell or hold briefly in the reject position.

Transit times of 45 to 180 milliseconds are common for the 82-inch travel from the detector to rejector, and slower transits are possible. A rejector operating time of 40 milliseconds and hold time of 250 milliseconds were selected as design points.

It is necessary for the machine to extend the hold time if two or more pieces of tramp iron are in transit and separated by time intervals less than the hold time. A circuit for performing this hold-time extension can be seen in the Fig. 2 diagram. This involves the thyratron resetting relay, the hold-time capacitor, and the reject-gate solenoids. The solenoids are energized by the capacitor charging current. The capacitor is discharged by the thyratron and the thyratron is reset by the relay. Passage of a piece of tramp iron through the inspection coil during a hold time causes the thyratron to discharge the capacitor, initiating another hold-time period as an extension of the previous one.

One-fourth to one-half pound of hay is carried with each rejection. Reducing the hold time from 250 to 150 milliseconds lowered the catch efficiency from 90 to 65 per cent and resulted in about a one-third saving in rejected hay.

Digest of paper 58-1006, recommended by the AIEE Domestic and Commercial Applications Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, Sacramento, Calif., Aug. 19-22, 1958. Scheduled for publication in AIEE *Applications and Industry*, 1958.

F. C. Jacob and J. B. Dobie are with the University of California, Davis, Calif

City-Wide Personal Signaling at Allentown–Bethlehem, Pa.

C. R. KRAUS
MEMBER AIEE

Features of Personal Signaling Service, a new development in the telephone communications field, include pocket-carried receivers and a selective signaling system. Results of a study made after 10 months of operation in the Allentown–Bethlehem area are outlined.

IF YOU HAPPEN to be either in Allentown or Bethlehem, Pa., one of these days and hear a low whistle coming from the coat pocket of the man standing next to you, don't become alarmed. The sound is actually coming from his coat pocket. Listening to it, you may wonder what is going on; but he won't. He will simply head for the nearest telephone and dial a number.

To you, of course, what you heard will be just a strange new sound. To the man with the whistle in his pocket, it is a new kind of telephone service that for some time now has been functioning in the Allentown–Bethlehem area on an experimental basis.

Known as Personal Signaling Service, this new development in the telephone art is consistent with one of the basic objectives in furnishing complete telephone service, i.e., making sure that the maximum number of calls are completed and that the calling party reaches the person with whom he wishes to speak.

THE NEED FOR SIGNALING SERVICE

TO ATTAIN such a dual objective successfully obviously suggests the need for reaching the called party when he is not in the immediate vicinity of his telephone. One effort in this direction has been the provision of extension bells which the telephone company has been furnishing for many years. Others in the past have been the provision of code calling or paging systems by means of which, through audible tones or voice, the wanted person can be called to the telephone if he is anywhere on the premises. Such devices have definite limitations, however, and they are useless when the desired individual is away from his premises.

Selective signaling service to receivers mounted in vehicles is another useful Bell System communications device directed toward this same objective.

Radio paging pocket-carried receivers which are signaled on a nonselective basis by voice operation also offer possibilities and have a definite field of use, since with them transmission of messages as well is possible. Unfortunately, however, these pocket-carried receivers also have several limitations. First, it is required that the user take certain action at rather frequent intervals; he must turn on his receiver and listen through a cycle of codes or messages to find out whether or not he is being paged. Not only is the individual inconvenienced, but also, and of much greater significance, he is unavailable during the period when he is not listening to his receiver. Second, there is a limit to the number of customers who can be served over a signal channel. This limit is the natural consequence of the number of times a particular code or message must be repeated in order that the individual being paged will hear it. As the number of customers to be served increases and the number of messages to be put on the air simultaneously becomes greater, the length of the listening cycle increases proportionately.

By contrast, the user of the selective signaling system hears only his own signal when it is sounded over his pocket-carried receiver. No listening cycle is involved; the signal is received at virtually the same time it is transmitted. The service also has an advantage over the vehicular selective signaling service because it eliminates the requirement that the user remain in the proximity of his vehicle. The advantage of selective signaling to pocket-carried receivers, therefore, is to increase substantially the ability of calling parties to communicate with the individual carrying the receiver. As a result, the system is ideally suited to doctors, lawyers, and other professional men, as well as to many types of business which must maintain fast, certain, and economical contact with their personnel.

HOW THE SERVICE FUNCTIONS

A BRIEF GENERAL DESCRIPTION of how the service functions may best be understood by reference to Fig. 1. Assuming that the customer is wanted, that he presumably is somewhere in the area, and that he has with him his pocket carried signaling receiver, the steps in the operation of the service are as follows:

1. His secretary or some other prearranged party dials a special number and reaches the telephone company's signaling operator. The secretary advises the operator of the number to be signaled. This is a 4-digit number.

2. The signaling operator "dials" the 4-digit number. She also records the information for billing purposes.

Full text of paper 58-813, presented at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Recommended for publication by the AIEE Radio Communication Systems Committee.

C. R. Kraus is with the Bell Telephone Company of Pennsylvania, Philadelphia, Pa.

3. Four voice-frequency tones are transmitted by the radio transmitters over the 35-mc channel.

4. The customer's pocket receiver is actuated by the four voice-frequency tones and the customer receives the signal, in the form of a pleasant whistle.

5. On being alerted, the customer presses the cutoff button to stop the whistle and calls his office or some other prearranged point from the nearest telephone.

HOW IT CAME ABOUT

THE TELEPHONE COMPANY offers three types of mobile telephone service. The first of these—General Mobile Service—provides for two-way telephone communication between a mobile unit within range of a radio base station and any wire telephone or between two such mobile units. The second—Dispatching Service—provides for two-way telephone conversation between a designated dispatching office of a customer in a mobile service area and a designated mobile unit of the customer within the range of the radio base station. The third—Selective Signaling Service—is a one-way service from any wire telephone located in a mobile service area to a mobile unit equipped for such service within range of the land radio station serving that area.

Selective Signaling Service is furnished only to receivers mounted in vehicles. The Allentown–Bethlehem Personal Signaling Service is an extension of this same type of service to pocket-carried receivers.

COMPARISON OF SYSTEMS

IN ANY DISCUSSION of this new selective type of service, an obvious question is how it fits in with existing voice paging services and other types of selective signaling systems which stem from the basic concept of a modulating system for transmitting a number of voice-frequency tones and a receiver which is individually sensitive to a specific succession of certain tones.

The voice system, of course, satisfies a definite need and fulfills requirements so far as the transmission of a message is concerned. However, with a large number of receivers in a system, the voice system can be inadequate because of the large amount of voice traffic. By contrast, a selective signaling system has inherent in it a capacity for handling a large number of customers. For example, the system installed in the Allentown–Bethlehem area is a city-wide signaling system with a capacity of approximately 3,200 receivers, any one of which can be signaled. This means that the system capacity is sufficient to make the service available to all prospective users in a sizable service area.

There are many places where a system with a capacity for a smaller number of receivers and with a fewer number of digits to be transmitted is suitable, such as individual buildings, manufacturing plants, hospitals and similar locations. A description of these simpler private systems, together with information on the fundamental modulating system and the details of the transistorized receiver with its selective mechanism, is covered elsewhere.[1]

OBJECTIVES

THE OBJECTIVES of the experimental installation of personal signaling service in the Allentown–Bethlehem area are in two categories—commercial and technical. Commercially, the area was selected as a good location to explore the possibilities of the field of use of a city-wide system. It was installed to determine the types and number of customers who would find a use for the service, as well as the amount of use which the customers would make of the service. Fundamentally, the question to be determined is whether this sort of a system will find sufficient customer acceptance to justify its existence.

Technically, the objectives were to determine the quality of performance of the equipment components of the system and to obtain sufficient experience in service to formulate basic operational needs.

DESCRIPTION OF THE SYSTEM

THE ALLENTOWN–BETHLEHEM SYSTEM consists of two radio base station transmitters arranged to signal pocket-carried receivers selectively. In addition to the transmitters, control equipment as shown in Fig. 2 is part of the system. A device called a memory is installed at the switchboard, and the operator selects the voice tones to be transmitted by setting dials on the memory bank.

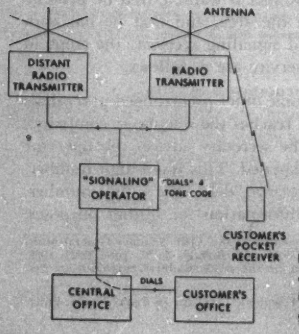


Fig. 1 (left). Block diagram of Personal Signaling Service. Fig. 2 (right). Block diagram of control equipment.

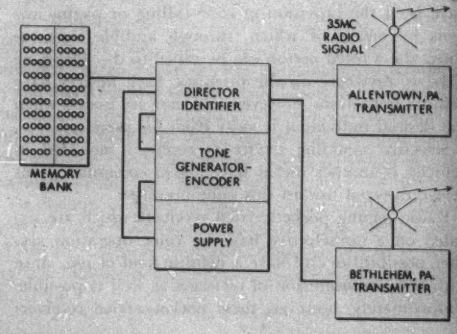


Fig. 3 (left). Transmitter. Fig. 4 (center) Transmitter housing and antenna. Fig. 5 (above). Memory bank.

The tone generators and other equipment modulate the radio-frequency carrier and perform other necessary functions.

The AM transmitters (Fig. 3) are Erco model *301TA*, having an output of about 250 watts and designed to operate in the 30- to 40-mc band. They are operated simultaneously, one at 35.3378 mc and one at 35.3412 mc. This separation of 3.4 kc between transmitter frequencies removes the beat note from the signaling tone band. The antenna structure associated with each transmitter is of standard design consisting of an Andrew type *900* folded unipole antenna. Fig. 4 shows one transmitter housing and antenna on the roof of the Allentown telephone central office building. The other transmitter is located in the Bethlehem telephone central office building.

Control Equipment. The memory bank which is part of the control equipment is shown in Fig. 5 and consists of a panel containing dials for selecting and storing codes to be transmitted. A maximum of 24 different codes may be selected at one time. The codes selected are stored and each is transmitted three times sequentially by means of a self-contained, electrically operated scanning mechanism. The scanning is continued as long as codes are present in the memory bank. When the scanning is stopped, station identification is transmitted and both transmitters are shut down.

The tone generator, with associated equipment, is pictured in Fig. 6. It is mounted in the equipment room on the second floor of the Allentown central office. The tone-generating unit makes available nine different audio frequencies, quartz-crystal controlled, in the range of 160-300 cycles. The frequencies are selected in groups of four tones for individual calling codes. The four tones comprising a code are transmitted sequentially and require approximately two seconds for transmission. With this signaling arrangement, it is possible to select one individual pocket-carried radio receiver out of a group of over 3,200 such receivers.

The director unit, also shown in Fig. 6, controls the radio transmitters and arranges for the scanning of the codes in the memory bank and for transmission of the codes to the radio transmitters. Station identification by international Morse code is automatically transmitted over one of the transmitters once every half hour during continuous transmission. In addition, station identification is automatically transmitted immediately prior to any period during which both transmitters have been shut down. The radio transmitters are remotely controlled by means of a d-c potential applied over wire lines.

Other Control Equipment. There are two keys and two lamps installed in the test center on the fourth floor of the Allentown central office. One key is associated with each transmitter. The keys are normally in the "on" position. When they are turned to the "off" position, they prevent the transmitters from being placed on the air. The lamps indicate when either of the transmitters is turned off. This arrangement is shown in Fig. 7.

Receiver. The receiver, shown in Fig. 8, is of a transistorized, super-regenerative type and weighs about 8 ounces. It includes an electromechanical selective mechanism consisting of four reeds which respond to individual frequencies and a hearing-aid-type speaker for signaling.[1]

Coverage and Transmission Design. A discussion of the transmission design and a review of the coverage results together with certain important data on shielding by buildings at both 30-40 mc and 150 mc are given in a paper by Walter Strack of the Bell Telephone Laboratories, Inc.[2]

OPERATING EXPERIENCE

As the result of more than 10 months of operation, it is concluded that

1. The service fulfills a need as evidenced by extensive usage and steady growth in the number of customers.

Fig. 6 (left). Tone generator and associated equipment. *Top: Director unit; Center: Tone-generating unit; Bottom: Power supply.* **Fig. 7 (center). Other control equipment. Fig. 8 (above). Receiver.**

2. The maintenance problems, particularly with the receiver, are somewhat greater than expected. However, further work is in progress and improvement is anticipated.

3. The size, shape, and weight of the receiver could be improved.

4. There are some service problems in regard to handling equipment outages.

The experiences summarized in the foregoing will be of benefit in the further development of the system.

CONTEMPLATED IMPROVEMENTS

A NUMBER OF IMPROVEMENTS in operation are contemplated for the service. Some of these are:

1. Dial operation at the switchboard rather than manual setting of the four dials for each call.

2. Use of existing mobile 35-mc systems with signal selective calls interposed between conversations.[2]

3. The contemplated use of 150-mc FM stations now in existence; awaiting the availability of suitable FM personal receivers having a selective signaling arrangement included.

CONCLUSION

PERSONAL SIGNALING SERVICE has established itself in the Allentown–Bethlehem area as an essential part of a telephone service that is ever expanding in scope. From an operational standpoint, the experiment disclosed areas in which improvement is desirable. Some development work remains to be done, therefore, in order that the service may merit a high degree of overall customer acceptance.

REFERENCES

1. Pagemaster Receiving and Modulation Equipment, J. W. Young. AIEE *Transactions*, vol. 77, pt. I, 1958 (Jan. 1959 section).

2. Systems Engineering of Personal Radio Signaling Systems, Walter Strack. *Ibid.*

Computer Reduces Weigh-In Time

Production of an electromechanical computing device for use in airline terminals has been announced by Detecto Scales, Inc. The automatic baggage computer records weight of passenger's baggage, deducts free weight allowance, shows amount of overweight, and computes the charge for excess poundage according to destination, all in 6 seconds from actual weigh-in to presentation of baggage ticket to the passenger.

Giant jet airliners have double the seating capacity of conventional planes and, consequently, airlines must clear twice as many passengers as before at a given departure time. The computer will cut down last-minute bottlenecks by reducing weigh-in time per passenger.

Power Transformer Design with an IBM *650*

L. J. MacKINNON
ASSOCIATE MEMBER AIEE

THE OBJECTIVE of a power transformer design and estimate cost program is to supply accurately and quickly output data which not only meets the desired design characteristics, but also results in the most efficient utilization of labor and materials. A program to supply complete core and winding, tank and cooling equipment and estimate cost data for any two or three winding power transformer of 2,500 to 50,000 kva requires 7 times the available internal storage of the IBM (International Business Machines) *650* digital computer. The *650* magnetic drum permits a maximum storage space of 2,000 ten-digit words, with each instruction or constant constituting one word space. The program instructions and constants are loaded by punched cards, which makes it desirable to maintain iterative calculations within the capacity of the drum; the alternative is to reload data. Some iterations would necessitate the loading and reloading of decks of punched cards a number of times.

Design criteria such as desirable conductor sizes, winding temperature and reactance are essential for any design, but to realize the maximum benefits from a computer it is necessary also to include major criteria such as total loss and optimum cost. Unfortunately, it does not seem practical or economical to incorporate either of the latter two criteria in a lengthy card input program. However, the use of alternative designs permits the design engineer to choose the most suitable design for a total loss, cost, total weight or dimension criteria.

Because the length of the program requires seven times the internal storage capacity of the *650*, the program data has been prepared in groups of approximately 2,000 instructions and constants; each group is referred to as a drum of instructions. Fig. 1 shows a general flow chart of the number of consecutive drums of instructions, including constants, necessary for the complete program; the only iteration between drums is shown between drums 1 and 1-A.

The variable input data required for the program is loaded with the first deck of cards, and contains the kva, voltages, reactance, and frequency from the customer specifications, plus values from the designer specifying the kv test and type of each winding, the estimated winding temperature rise and the core leg area; the input sheet also provides space to list alternative values of winding temperature rise or core leg area, or both. The use of alternative designs results in various design characteristics and costs, and thus the designer may choose the design which not only meets the desired criteria but also results in the most efficient use of labor and materials. The input data is teletyped to the computer installation 150 miles from the transformer plant, and thus it is desirable to maintain at a minimum the number of values.

CONCLUSIONS

THE TYPE OF PRODUCT, volume of business, and, thus, the economic gain that may be expected from the utilization of a digital computer determine the rental charge that a user can justifiably afford. The advantages of using a digital computer are numerous, but unfortunately the true technical and economical benefits are difficult to evaluate conclusively. The computer speed is an important feature when considering the efficiency of operation. The program stated requires an average of 4 minutes of calculation time on the computer; the average period for loading the punched cards is 14 minutes. Thus, complete design and estimate cost data for a design and three alternatives may be received in 72 minutes. Another major advantage which can be attributed to the use of a computer is the necessary detailed study of the existing practice which must precede any program analysis. This work not only results in a more acceptable practice for computer operation, but also frequently results in a more systematic manual practice in contiguous areas. The latter advantage becomes more important as integrated programs are prepared to follow the engineering and estimated cost program.

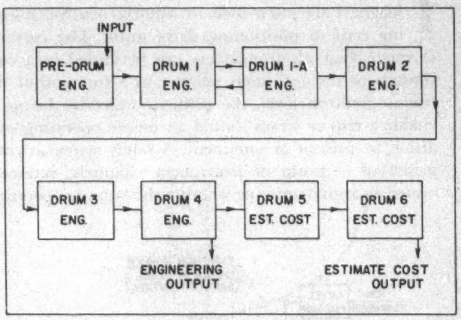


Fig. 1. General drum flow chart of program.

Digest of paper 58-1095, "Power Transformer Design and Estimate Cost Program with an IBM *650* Digital Computer," recommended by the AIEE Computing Devices and Transformers Committees and approved by the AIEE Technical Operations Department for presentation at the AIEE Power Industry Computer Application Conference, Toronto, Ont., Canada. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

L. J. MacKinnon is with the Canadian General Electric Co., Ltd., Guelph, Ont., Canada.

Variation of the Trip Point in the ORNL Type Safety System

J. L. COCKRELL
MEMBER AIEE

C. W. RICKER

In reactor control instrumentation, such as the ORNL (Oak Ridge National Laboratory) system, certain interactions accompany the interconnection of safety amplifiers. These interactions, or loading effects, are discussed in order to facilitate understanding of the unavoidable variations in trip or scram point.

IN NUCLEAR REACTOR safety systems, electromagnets are often used to connect neutron-absorbing rods to positioning drive units. The currents through these electromagnets can be varied in a continuous or discontinuous manner as a function of the reactor neutron level, the ultimate objective being to enable a trip or scram should an unsafe operating condition be present or imminent. A safety system is comprised of a group of instrument channels, interconnected so as to determine whether the "unsafe operating condition" exists and, upon such determination, to trip the rods, all with no operator attention. One such safety system is the so-called "auctioneering" array of safety amplifiers, all deriving information from separate channels, and jointly feeding a single common point of interconnection or bus. The state of this bus is determined by the highest bidder (the channel with the highest output voltage). Thus, a single channel, detecting an unsafe condition, is able to assume control and eventually shut down the system.

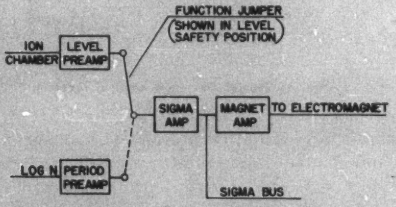


Fig. 1. Composite safety amplifier (signal circuits).

The functioning of the individual channels, their inputs, and the interaction of a group of these channels, must be known so that due consideration may be given in setting up the equipment to cause trip to occur under the proper conditions.

Full text of paper 58-709, recommended by the AIEE Nucleonic and Radiation Instrumentation Committee and approved by the AIEE Technical Operations Department for presentation at the Nuclear and Engineering Science Conference, Chicago, Ill., Mar. 17-21, 1958. Published in AIEE *Communication and Electronics*, Nov. 1958, pp. 699-703.

J. L. Cockrell is with the Leeds & Northrup Company, Philadelphia, Pa., and C. W. Ricker is with the University of Michigan, Ann Arbor, Mich.

SAFETY CHANNEL

THE COMPOSITE SAFETY AMPLIFIER (ORNL *Q-1565*), shown in Fig. 1, is representative of a class of instruments designed to perform the safety function described hereinbefore. It contains both a level preamplifier and a period preamplifier, but only one of these two is used at a time. The composite safety amplifier is a single channel in itself and is generally used in a system of three or four channels, as shown in block diagram form in Fig. 2.

The right-hand composite safety amplifier has the period preamplifier connected; the other amplifiers have their level preamplifiers in use.

The preamplifiers, whether level or period types, are linear and are designed to accept input signals proportional to the neutron flux of the reactor. The level preamplifiers receive currents up to about 50 microamperes at 150% full power from ion chambers (suitable for about 3 decades below full power), and deliver output voltages of 22 volts at zero power and 22 + 15 or 37 volts at 150% full power. The period preamplifier derives its information for the log n amplifier (suitable for about 6 decades below full power). This input, in the form of a voltage, is first differentiated and, after amplification, is delivered as an inverse period signal which covers exactly the same range of voltages as delivered by the level preamplifiers. Here an infinite period, corresponding to zero rate of change of reactor power, will be evidenced by 22 volts at the period preamplifier output. A period of about one second will cause a preamplifier output of about 37 volts, depending on the exact differentiating circuit elements and the amplifier gain.

The sigma amplifiers are identical and establish the voltage of the point of system interconnection—here called the sigma bus. This voltage is the input to all the magnet amplifiers, which are linear and, in turn, supply currents to the individual electromagnets. The sigma amplifier, herein described, is of particular interest and will be considered in detail, both as a component and as an interconnected part of the over-all safety system.

Even when the magnet currents are continuous functions of reactor power level, as in the composite safety amplifier system, it is desirable that they vary only a small fraction of their nominal zero power value when

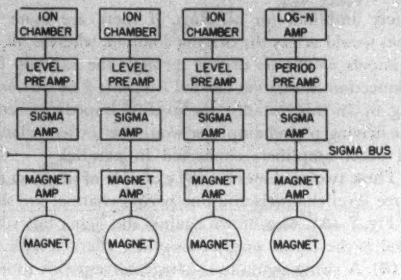


Fig. 2. ORNL type safety channels and system.

the reactor is experiencing normal power excursions or transients. In order that the magnet currents will decrease rapidly when abnormal power excursions or transients occur, a nonlinear link in the channel is necessary. The safety or sigma amplifier is this nonlinear link, and it carries the dual role of generating the input–output nonlinear relation and of providing coupling between the individual channels. All other parts of the circuit, before and after this sigma amplifier, are linear and do not interact between channels except, of course, through the reactor power. Fig. 3 shows the typical circuit arrangement of the sigma amplifier, and Fig. 4 is the approximate characteristic of a single amplifier of this type.

V_1 is a conventional cathode follower driver which delivers the input voltage to the sigma amplifier tube V_2 through R_3. V_3 is a clamping diode which maintains the grid voltage, and thus the output voltage, essentially constant for low signal inputs. This amplifier is designed to be operated with the level preamplifier and ion chamber so that each input volt above the 22 volts shown is equivalent to 10% of reactor power. Thus, full power occurs at 32 volts and the overload power of 150% occurs at 37 volts. Note that the diode clamping action ceases at about 70 or 80% of full power. When driven by the period preamplifier, an input of 22 volts corresponds to an infinite period while 37 volts corresponds to the trip period (usually 1 second).

Conventionally, the sigma amplifier is followed by a linear magnet amplifier which decreases in output electromagnet current about 5 milliamperes for every volt rise in the sigma bus. The actual magnitude of magnet current, for any input voltage, can be adjusted, and is generally set to give a trip or scram at a particular value of voltage input to the magnet amplifier. This voltage input is the same as the output voltage of the sigma amplifier and is the point of system interconnection. Thus, the name "sigma bus" has been attached to this point.

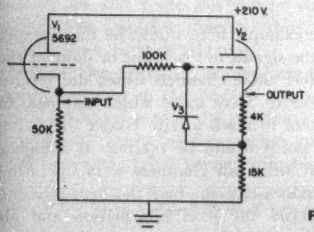


Fig. 3. Sigma amplifier.

INTERCONNECTION AND INTERACTION

THE OUTPUT IMPEDANCE of a cathode follower is normally expressed in terms of the parameters of the circuit and tube, and is of the usual form

$$Z_{out} = \frac{R_K r_p/\mu}{R_K + r_p/\mu} = \frac{r_p}{u + r_p/R_K} \qquad (1)$$

where R_K is the value of the cathode resistor, r_p is the dynamic plate resistance of the tube, and μ is the amplification factor.

If r_p is not a constant, the impedance presented by the cathode follower to an incremental voltage change impressed on the cathode of the tube is more conveniently expressed as:

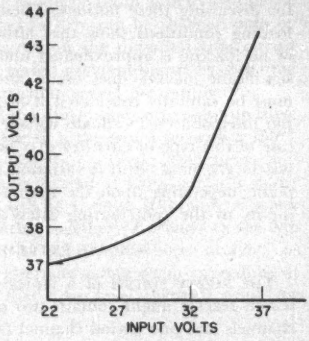


Fig. 4. Sigma amplifier characteristic.

$$Z_{out} = \frac{R_K}{(\mu R_K/r_p) + 1} \qquad (2)$$

where r_p appears only once.

When the cathode is being driven positive by a voltage from an external source (for instance, another cathode follower), the tube current decreases, r_p increases, and the Z_{out} value approaches the value of R_K On the other hand, when the cathode is driven negative, the tube conducts more strongly, r_p becomes stabilized, and the Z_{out} approaches r_p/μ (for the usual case when $\mu R_K/r_p \gg 1$). This variation is shown in Fig. 5 for a typical *Q-1565* sigma amplifier.

The significance of this change in output impedance when several of these amplifiers are connected together at the cathodes, is that some interesting system results are possible. In particular, if a single tube cathode voltage increases because of a positive-going voltage on its grid, this action tends to decrease the impedance of the

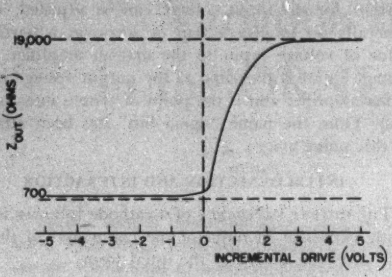


Fig. 5. Input impedance variation.

driving tube and, at the same time, to increase the loading impedance of the driven tubes (decreasing the loading). One might ask if (in the limit) the loading of the driving tube by the driven tubes could be made negligible. The data for Fig. 6 were taken in the laboratory on a simulated system of four sigma amplifiers and driving stages in order to establish a quantitive basis for discussing these notions. These curves for various loading conditions show that although the condition of no loading is approximated under some conditions, significant loading does occur, and that this loading must be carefully considered if accurate knowledge of the interconnected cathode voltage is desired. For the case of this type of circuitry in a nuclear reactor safety system, the final result is variation in the trip or scram point, depending upon the nature or combination of inputs to the contributing safety amplifiers.

NORMAL EXTREMES

THE SAFETY SYSTEM of a typical swimming-pool research reactor might contain two or three level safety channels and one period channel (as shown in Fig. 2). This gives rise to two normal extremes of safety action. One is the case arising from a very slow rise to an overload condition, but where the period safety amplifier is supplying negligible information. The level channels will be receiving the information from their separate ion chambers corresponding to this rising power level. If the channels are properly adjusted and calibrated, they will show a simultaneous slow rise in cathode voltage. (The level channels are driving the sigma bus upward in voltage.) The period safety, on the other hand, is receiving no significant information, and its cathode will be driven by the rising cathodes of the level channels. Any loading that would occur is by the single period channel alone (or all period channels if there should be more than one). This loading for the instances of two or three level channels is shown in Fig. 5 by the curves titled *2 driving 1* or *3 driving 1*. In either event, the departure from the *unloaded* curve (single-unit characteristic) is quite small.

The other extreme is that encountered when the reactor power level is a decade or more below full power, but is rising rapidly enough to cause significant output from the period safety channel. Here the single period safety amplifier (or all such, if there are more than one) would act as the driving channel, whereas all level channels would be driven through the cathode interconnection (see curves labeled *1 driving 2* or *1 driving 3*, Fig. 6). In this instance, the loading impedance seen by the driving period amplifier would be the impedance of all other amplifiers connected in parallel.

These two extremes for the example of a system using three level channels and one period channel are shown in Fig. 7 (A). Also shown against the sigma bus voltage level is the linear magnet amplifier characteristic, Fig. 7 (B). A rising sigma bus voltage corresponds to a falling magnet current. It is important to note that, for a given *magnet current* adjustment, the point at which the electromagnets release is determined only by the sigma bus voltage level.

Figs. 7 (A) and (B) are read for a given situation (for example, *3 driving 1*) by noting a given input signal V_1 produces a sigma bus level L_1 which causes a magnet current I_1. A higher input signal V_2 produces a sigma bus level L_2 and a magnet current I_2. Note again that when the magnet current adjustment has been made, the position of the magnet amplifier characteristic in Fig. 7 (B) is determined and the sigma bus level must be up to L_2 to cause a trip. If only one safety amplifier receives an input (*1 driving 3*), its input must proceed to V_2 before the trip point is reached.

ABNORMAL EXTREMES

IN ORDER TO EVALUATE the significance of these curves, we must know under what conditions the various curves in Fig. 7 (A), shown in detail in Fig. 6, represent actual situations. The normal extremes of level and period trips have been described. However, certain conditions under which the equipment is operating abnormally

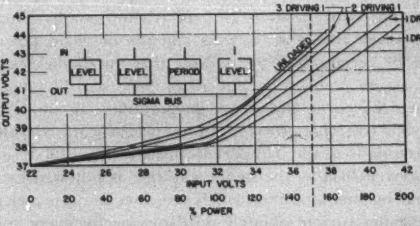


Fig. 6. Loading characteristics of safety amplifiers for various driving conditions.

are possible. One example here would be the instance of the failure of the signals to reach one or more of the level channels. Here those channels which did receive signals would have to drive those which did not, in order for the system to reach a trip. Under these conditions, the trip point would be reached at a higher signal input than when all channels were operating normally. The obvious extreme here is when only one level channel receives the level information and all

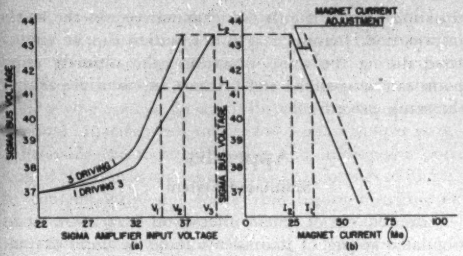


Fig. 7. Over-all transfer characteristic.

other channels are either inactive or have failed. The curve *1 driving 2* or *1 driving 3*, as the case may be, represents this situation. Many other combinations are possible which will generally fall between the extremes described.

SYSTEM SETUP PROCEDURES

IN THE LIGHT of the foregoing, it is not possible, using this equipment, to prescribe a reactor trip power which will be the actual trip power under all circumstances. Accordingly, it is well to examine how the trip point is inserted into this safety system, what the alternatives for the setup might be, and the resultant actual trip points.

Qualitatively, setting the trip can be summarized by three distinct steps:

1. Determine the situation for trip.
2. Simulate the situation by means of corresponding voltages at the inputs to the sigma amplifiers.
3. Set the magnet currents to the drop value.

Removing the simulated input voltage now makes the system ready to accept actual operating information. When the input signals from the ion chambers are properly related to the actual reactor power, then trip for the situation determined previously in step 1 is assured.

A particular example of carrying out these steps is helpful in bringing to light some of the details involved. If the criterion for trip is an absolute maximum reactor power, this trip is set into the interconnected safety system as follows:*

1. Determine the percentage of full power at which trip is required.
2. Convert the power of step 1 to a simulated voltage magnitude and apply this voltage successively to each level sigma amplifier (one at a time), noting the sigma bus voltage in each instance.
3. With the lowest sigma bus voltage determined in step 2 applied to the bus, set the magnet current in each electromagnet to the previously determined drop current by means of the magnet current adjustment. (Be sure that all bus protect adjustments are disabled.)

*Normal bench test and description of all routine setup procedures are described in ORNL Central Files no. 56-5-30, Section P.

These steps assure that if any one level sigma amplifier receives an input corresponding to the power mentioned in step 1, the sigma bus voltage will be raised to the voltage corresponding to the magnet drop currents of all electromagnets. When two or more level sigma amplifiers receive such inputs, the sigma bus is raised to the trip point at a lower value of reactor power according to the curves *2 driving 1* and *3 driving 1* of Fig. 6.

Having once determined the sigma bus trip voltage, it is important to understand that the reactor period (operating through the log *n* circuit and the period safety circuit) which raises the sigma bus to this trip voltage is the trip period. When the sigma bus trip voltage is reached by the period sigma amplifier acting alone (at low power), the reactor period causing this rise is the limiting period and must be consistent with the operating and safety philosophy at the site concerned. At higher powers—approaching full power—the level sigma amplifiers contribute to the sigma bus voltage, and a slightly longer period will trip the system. Furthermore, for a given sigma bus trip voltage and any specified loading condition (both as described in the foregoing), the period for trip can be changed only by altering the components in the differentiating circuit at the input to the period preamplifier or by changing the gain of that particular period preamplifier.

Some figures from the illustrations may point up these facts. Referring to Fig. 6, if the trip is set with a 150% power signal (37 volts) into a single level sigma amplifier, then the trip is assured at 150%, and the sigma bus voltage for this will be 41 volts. If three level safety channels were operating together (*3 driving 1*), the trip (sigma bus raised to 41 volts) would occur at 126% of full power. As an alternate safety setup procedure, it might be assumed that three level channels would be

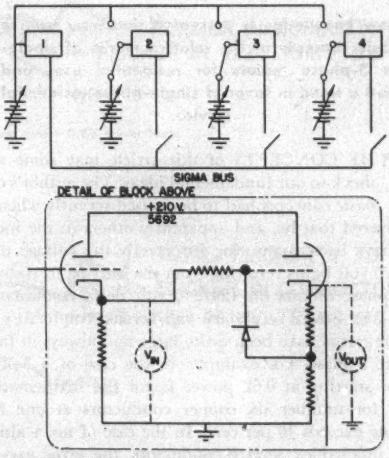


Fig. 8. Interconnection test scheme.

operating normally to bring the sigma bus voltage up during a power excursion. To simulate this condition, the 150% power signals would be applied at the same time to the inputs of all three level sigma amplifiers. Note that the sigma bus voltage for trip is now 43 volts. Now a power rise to 150% full power would trip the system if all channels were operating normally, but it would require a rise to 180% of full power in order to insure the trip if, for any reason, only one sigma amplifier could see the power rise. If a 1-second period is required to raise the sigma bus to 41 volts, the same period circuitry would require a period of about 0.83 second to raise the bus to 43 volts. Thus, for the first setup situation in this paragraph the trip period is 1 second. The second setup situation would require a 0.83-second period for trip.

CONCLUSIONS

FROM THESE EXAMPLES, it is apparent that the actual trip power can vary over a significant range of reactor power. However, the highest power which the system could allow under any combination of circumstances (except failure of all channels) is determined by the situation present if only one channel receives the level information. Inasmuch as this situation can be simulated during the setup procedure, the ultimate trip point can be specified and becomes an essential part of the setup procedure.

Appendix

Simulated System

Measurements of system interaction were made on a simulated system of four identical sigma amplifiers as shown in Fig. 8. In addition, because the clamping currents will flow through the diode and the driving output circuit, each sigma amplifier was supplied by a cathode follower exactly as done in the actual system.

The input and output connections were made in ways to allow complete versatility of interconnection scheme. All voltages were read within ¼ volt and corrected by a 0.25% Rawson Polyranger Meter. The readings on the sigma bus where loading was being observed were made on the RCA Voltohmyst. All other readings were made by accurately calibrated panel meters.

Flicker Effects of Single-Phase and 3-Phase Motors Compared

BRYCE BRADY
FELLOW AIEE

New knowledge is presented that may reverse basic concepts of the relative merits of single- vs 3-phase motors for residential uses and start a trend in favor of single-phase residential service.

THE CONCEPTS of this article may come as a shock to our fundamental ideas. The author's own basic concepts had to be revised recently when he discovered that he, and apparently others in the industry, have been computing incorrectly the voltage drop on 120 volt lights resulting from the starting or running of 3-phase motors on 120/240 volt delta combination light and power secondary and service conductors.

The errors have been quite large and always in favor of the 3-phase. For example, in the case of a 3-phase motor starting at 0.62 power factor the mathematical error for number six copper conductors at one foot spacing exceeds 40 per cent. In the case of no. 4 aluminum quadriplex service conductors, the error exceeds 60 per cent.

The necessity of making plus and minus 30 degree adjustments in the phase relations between 3-phase currents and single-phase voltages has been known for decades when computing the voltage drop in the leading and lagging transformers, respectively, of open Y–open delta and open delta–open delta transformer banks. For some unknown reason, the necessity has been overlooked of also making plus and minus 30 degree adjustments in the phase relations between 3-phase currents and 120-volt single-phase voltages in 120/240-volt 4-wire delta combination light and power secondary and service conductors, when computing the voltage drop in the leading and lagging conductors, respectively. This 30 degree adjustment is always necessary regardless of whether the transformer connection is open or closed delta.

In this article, the author gives voltage-current dia-

A special article recommended by the AIEE Rotating Machinery Committee.

Bryce Brady is with the Oklahoma Gas and Electric Company, Oklahoma City, Okla.

grams; formulas for determining steady and flicker voltage drop affecting devices served at 120 volts; a table giving voltage flicker in conductors of equal weight when single- and 3-phase motors start; and a table giving voltage flicker in distribution transformers of equal capacity when single- and 3-phase motors start.

Probably the most interesting and informative portion of the article is a table listing 27 examples of flicker in contemporary and foreseeable future distribution transformer-secondary-service systems. This table shows that, in most instances, the starting of single-phase motors causes less flicker on lights and television sets than does the starting of 3-phase motors. This new knowledge may have far-reaching consequences in the present debate over the merits of single- vs 3-phase service to residences. It may help swing the pendulum in favor of single-phase residential service.

CONDUCTOR FLICKER

TABLE I COMPARES the voltage flicker caused by conductors of equal weight when a 5-hp motor starts. Such flicker is usually most noticeable on 120-volt television sets and lights. In a predominant number of cases in the table, representing usual residential practice today and in the foreseeable future, the flicker is less when the motor is single-phase.

On the left side of Table I, the combination light and power service is single-phase, 3-wire, 120/240 volt served from one transformer as shown in Fig. 1. On the right side of the table, service is 3-phase, 4-wire, 120/240 volt delta served from two or three transformers as shown in Figs. 2, 3, or 4.

The author has not found where any of the technical literature has taken cognizance of the fact that the flicker on a television set or light connected between conductor *C* and lighting neutral *N* is very much more severe than on a television set or light in the same residence connected to conductor *B* in Figs. 2, 3, or 4. The flicker voltage drop may be over four times worse in conductor *C* than in conductor *B* as shown on the first line of Table I. Here the flicker values are 6.28 and 1.29 volts drop, respectively, on conductors *C* and *B*. The 6.28 volts drop is 5.2% on 120-volt base. This is the important criterion affecting quality of service to 120 volt devices. The 6.28 plus 1.29 volts amount to only 3.15% on 240 volt base. The 240-volt flicker is of importance only to 240-volt appliances.

TRANSFORMER FLICKER

TABLE II COMPARES the voltage flicker caused by transformers of equal capacity when a 5-hp motor starts. This flicker adds to that in conductors affecting the quality of service to lights and television sets. In the majority of cases shown, the flicker is less when the motor is single-phase.

Some electric utilities try to avoid the connection shown in Fig. 2. Others connect the lighting transformer in the open-delta connection either leading or lagging phase sequence at random. Insofar as flicker is concerned, there does not seem to be much to be gained by going to the extra trouble and expense required to avoid the Fig. 2 connection. The Fig. 2 connection actually is superior, from the flicker viewpoint, when the lighting transformer is 37½ kva or larger.

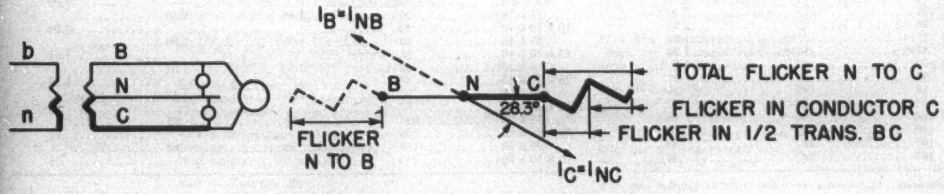


Fig. 1. Voltage flicker, starting a single-phase motor 0.88 power factor.

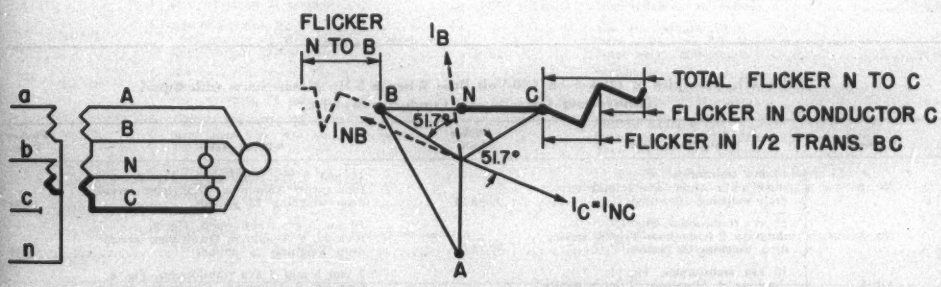


Fig. 2. Voltage flicker, starting 3-phase motor 0.62 power factor. Lights on lagging transformer of open Y—open delta connection.

Table I. Voltage Flicker in Conductors of Equal Weight When a 5-Hp Motor Starts

Single-Phase					3-Phase				
				Volts Flicker Fig. 1				Volts Flicker Figs. 2, 3, 4	
	Conductor	Weight pounds	In 120 Volt Conductors B or C		Conductor	Weight pounds	In 120 Volt Con-ductor B	In 120 Volt Con-ductor C
100 Foot Service Cable, Aluminum	3 No. 4 Aluminum Triplex	18	4.44		4 No. 6 Aluminum Quadriplex	16	1.29	6.28
	3 No. 2 Aluminum Triplex	27	2.86		4 No. 4 Aluminum Quadriplex	25	.93	4.01
	3 No. 1 Aluminum Triplex	34	2.28		4 No. 2 Aluminum Quadriplex	37	.69	2.57
	3 No. 1/0 Aluminum Triplex	43	1.84		4 No. 1 Aluminum Quadriplex	47	.61	2.05
	3 No. 2/0 Aluminum Triplex	54	1.49		4 No. 1/0 Aluminum Quadriplex	58	.54	1.65
	3 No. 3/0 Aluminum Triplex	66	1.21		4 No. 2/0 Aluminum Quadriplex	71	.48	1.33
	3 No. 4/0 Aluminum Triplex	81	.98		4 No. 3/0 Aluminum Quadriplex	88	.44	1.08
100 Foot Open Service Drop, Copper	3 No. 6 Copper Service	31	4.78		4 No. 8 Copper Service	28	2.05	6.44
	3 No. 4 Copper Service	47	3.23		4 No. 6 Copper Service	42	1.67	4.18
	3 No. 3 Copper Service	57	2.67		4 No. 4 Copper Service	62	1.59	2.79
	3 No. 2 Copper Service	76	2.23		4 No. 3 Copper Service	77	1.29	2.29
	3 No. 1 Copper Service	100	1.87		4 No. 2 Copper Service	101	1.21	1.89
150 Foot Span Secondary, Bare Cu and Al	3 No. 5 Copper Bare	45	5.91		4 No. 6 Copper Bare	48	2.49	6.29
	3 No. 4 Copper Bare	58	4.83		4 No. 5 Copper Bare	61	2.27	5.15
	3 No. 3 Copper Bare	72	3.99		4 No. 4 Copper Bare	77	2.08	4.19
	3 No. 2 Copper Bare	92	3.33		4 No. 3 Copper Bare	96	1.93	3.45
	3 No. 1 Copper Bare	116	2.79		4 No. 2 Copper Bare	123	1.81	2.83
	3 No. 2/0 Aluminum Bare	56	2.77		4 No. 1/0 Aluminum Bare	59	1.74	2.83
	3 No. 3/0 Aluminum Bare	70	2.34		4 No. 2/0 Aluminum Bare	75	1.62	2.33
	3 No. 4/0 Aluminum Bare	89	1.98		4 No. 3/0 Aluminum Bare	94	1.54	1.95
	3 No. 266.8 Aluminum Bare	112	1.70		4 No. 4/0 Aluminum Bare	118	1.44	1.63

PREMISES: Conductors at 50C Temperature. Open conductors at 1 foot spacing. Locked rotor current 5-hp single-phase motor, 105 amperes, 88% pf. Locked rotor current 5-hp 3-phase motor, 90 amperes, 62% pf. Average of several leading manufacturers.

Table II. Voltage Flicker in Distribution Transformers of Equal Capacity When a 5-Hp Motor Starts

Single-Phase			3-Phase				
					Volts Flicker In 120 Volts		
Transformer Size (kva)	Total kva	Flicker In 120 Volts Fig. 1	Transformer Sizes (kva)	Total kva	Fig. 2	Fig. 3	Fig. 4
15	15	4.10	10 & 5	15	5.60	3.50	
15	15	4.10	5 & 5 & 5	15			8.09
25	25	2.40	15 & 10	25	3.46	2.30	
25	25	2.40	10 & 10 & 10	30			3.04
37½	37½	1.70	25 & 15	40	1.98	1.66	
37½	37½	1.70	15 & 10 & 10	35			1.91
50	50	1.27	37½ & 15	52½	1.35	1.51	
50	50	1.27	25 & 15 & 15	55			1.21
75	75	.87	50 & 25	75	1.01	1.12	
75	75	.87	37½ & 25 & 25	87½			.95
100	100	.68	75 & 25	100	.68	.85	
100	100	.68	50 & 25 & 25	100			.71
167	167	.47	100 & 50	150	.53	.68	
167	167	.47	75 & 50 & 50	175			.51

PREMISES: Transformers are 7,200/12,470 to 120/240 volt.
Lighting transformer in Fig. 4 connection cannot be larger than the sum of other two transformers.
Transformer impedances from 1957 Edition, General Electric Distribution Data Book.
Locked rotor current 5-hp single-phase motor 105 amperes, 88% pf.
Locked rotor current 5-hp 3-phase motor 90 amperes, 62% pf.
Average of several leading manufacturers.

Table III. Examples of Flicker on 120-Volt Base When a 5-Hp Motor Starts with Equal Transformer Capacity and Conductor Weight.*

Examples	Single-Phase Motor	Flicker Volts	3-Phase Motor	Flicker Volts
No. 1	15 kva transformer Fig. 1, three no. 4 Aluminum Triplex service drop weighing 18 pounds	8.54	10 and 5 kva transformers, Fig. 2, four no. 6 Aluminum Quadriplex service drop weighing 16 pounds	11.88
No. 2	15 kva transformer, Fig. 1, three no. 2 Aluminum Triplex service drop weighing 27 pounds	6.96	10 and 5 kva transformers, Fig. 3, four no. 4 Aluminum Quadriplex service drop weighing 25 pounds	7.51
No. 3	15 kva transformer, Fig. 1, three no. 1 Aluminum Triplex service drop weighing 34 pounds	6.38	5 and 5 and 5 kva transformers, Fig. 4, four no. 2 Aluminum Quadriplex service drop weighing 37 pounds	10.66

Examples	Single-Phase Motor	Flicker Volts	3-Phase Motor	Flicker Volts
No. 4	25 kva transformer, Fig. 1, three no. 6 Copper open service drop weighing 31 pounds	7.18	15 and 10 kva transformers, Fig. 2, four no. 8 Copper open service drop weighing 28 pounds	9.90
No. 5	25 kva transformer, Fig. 1, three no. 4 Copper open service drop weighing 47 pounds	5.63	15 and 10 kva transformers, Fig. 3, four no. 6 Copper open service drop weighing 42 pounds	6.48
No. 6	25 kva transformer, Fig. 1, three no. 3 Copper open service drop weighing 57 pounds	5.07	10 and 10 and 10 kva transformers, Fig. 4 four no. 4 Copper open service drop weighing 62 pounds	5.83
No. 7	25 kva transformer, Fig. 1, one span 3 no. 2/0 Aluminum secondary, three no. 4 Aluminum Triplex service drop. Conductor weighs 74 pounds	9.61	15 and 10 kva transformers, Fig. 2, one span 4 no. 1/0 Aluminum secondary, four no. 6 Aluminum Quadriplex service drop. Conductor weighs 75 pounds	12.57
No. 8	25 kva transformer, Fig. 1, One span 3 no. 3/0 Aluminum secondary, three no. 2 Aluminum Triplex service drop. Conductor weighs 97 pounds	7.60	15 and 10 kva transformers, Fig. 3, One span 4 no. 2/0 Aluminum secondary, four no. 4 Aluminum Quadriplex service drop. Conductor weighs 100 pounds	8.64
No. 9	25 kva transformer, Fig. 1, one span 3 no. 4/0 Aluminum secondary, three no. 1 Aluminum Triplex service drop. Conductor weighs 123 pounds	6.66	10 and 10 and 10 kva transformers, Fig. 4, one span 4 no. 3/0 Aluminum secondary, four no. 2 Aluminum Quadriplex service drop. Conductor weighs 131 pounds	7.66
No. 10	37½ kva transformer, Fig. 1, three no. 4 Aluminum Triplex service drop weighing 18 pounds	6.14	25 and 15 kva transformers, Fig. 2, four no. 6 Aluminum Quadriplex service drop weighing 16 pounds	8.26
No. 11	Add to Example 10: one span 3 no. 4 Copper secondary. Total conductor weight 76 pounds	10.97	Add to Example 10: one span 4 no. 5 copper secondary. Total conductor weight 77 pounds	13.41
No. 12	37½ kva transformer, Fig. 1, three no. 2 Aluminum Triplex service drop. Conductor weight 27 pounds	4.56	25 and 15 kva transformers, Fig. 3, four no. 4 Aluminum Quadriplex service drop. Conductor weight 25 pounds	5.67
No. 13	Add to Example 12: one span 3 no. 3 Copper secondary. Total conductor weight 99 pounds	8.55	Add to Example 12: one span 4 no. 4 Copper secondary. Total conductor weight 102 pounds	9.86
No. 14	37½ kva transformer, Fig. 1, three no. 1 Aluminum Triplex service drop weighing 34 pounds	3.98	15 and 10 and 10 kva transformers, Fig. 4, four no. 2 Aluminum Quadriplex service drop weighing 37 pounds	4.48
No. 15	Add to Exampe 14: one span 3 no. 2 Copper secondary. Total conductor weight 92 pounds	7.31	Add to Example 14: one span 4 no. 3 Copper secondary. Total conductor weight 96 pounds	7.91
No. 16	50 kva transformer, Fig. 1, three no. 4 Copper open service drop weighing 47 pounds	4.50	37½ and 15 kva transformers, Fig. 2, four no. 6 open service drop weighing 42 pounds	6.16
No. 17	Add to Example 16: two spans 3 no. 2/0 Aluminum secondary. Total conductor weight 159 pounds	10.04	Add to Example 16: two spans 4 no. 1/0 Aluminum secondary. Total conductor weight 160 pounds	11.82
No. 18	50 kva transformer, Fig. 1, three no. 3 Copper open service drop weighing 57 pounds	3.94	37½ kva transformer, Fig. 3, four no. 4 Copper open service drop weighing 62 pounds	4.30
No. 19	Add to Example 18: two spans 3 no. 3/0 Aluminum secondary. Total conductor weight 127 pounds	6.28	Add to Example 18: two spans 4 no. 2/0 Aluminum secondary. Total conductor weight 127 pounds	6.33
No. 20	50 kva transformer, Fig. 1, three no. 2 Copper open service drop weighing 76 pounds	3.50	25 and 15 and 15 kva transformers, Fig. 4, four no. 3 Copper open service drop weighing 77 pounds	3.50
No. 21	Add to Example 20: two spans 3 no. 4/0 Aluminum secondary. Total weight 165 pounds	5.48	Add to Example 20: two spans 4 no. 3/0 Aluminum secondary. Total weight 171 pounds	5.45
No. 22	100 kva transformer, Fig. 1, three no. 2 Aluminum Triplex service drop weighing 27 pounds	3.54	75 and 25 kva transformers, Fig. 2, four no. 3 Aluminum Quadriplex service drop weighing 25 pounds	4.69
No. 23	Add to Example 22: three spans 3 no. 3/0 Aluminum secondary. Total weight 237 pounds	10.52	Add to Example 22: three spans 4 no. 2/0 Aluminum secondary. Total weight 250 pounds	11.68
No. 24	100 kva transformer, Fig. 1, three no. 1 Aluminum Triplex service drop weighing 34 pounds	2.96	75 and 25 kva transformers, Fig. 3, four no. 2 Aluminum Quadriplex service drop weighing 37 pounds	3.42
No. 25	Add to Example 24: three spans 3 no. 4/0 Aluminum secondary. Total weight 301 pounds	8.90	Add to Example 24: three spans 4 no. 3/0 Aluminum secondary. Total weight 319 pounds	9.27
No. 26	100 kva trannsformer, Fig. 1, three no. 1/0 Aluminum Triplex service drop weighing 43 pounds	2.52	50 and 25 and 25 kva transformers, Fig. 4, four no. 1 Aluminum Quadriplex service drop weighing 47 pounds	2.76
No. 27	Add to Example 26: three spans 3 no. 266.8 mcm Aluminum secondary. Total weight 379 pounds	7.62	Add to Example 26: three spans 4 no. 4/0 Aluminum secondary. Total weight 401 pounds	7.65

*Premises: All secondary spans are 150 foot. All service drops are 100 foot.

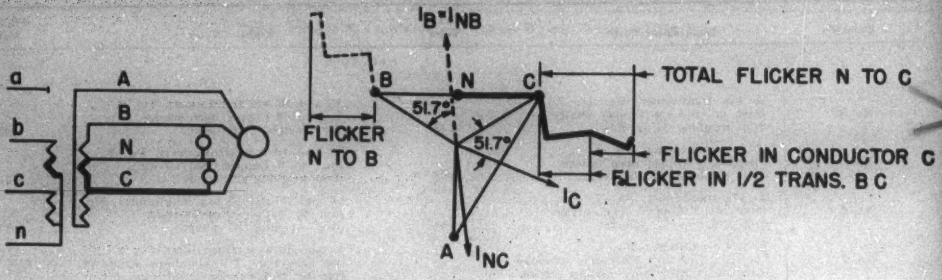


Fig. 3. Voltage flicker, same as Fig. 2 except lights on leading transformer.

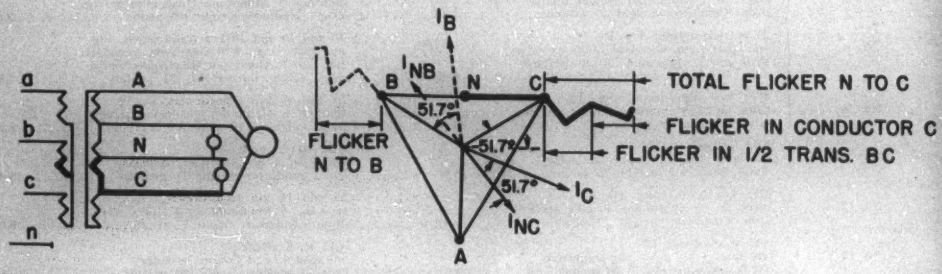


Fig. 4. Voltage flicker, same as Fig. 2, except closed Y–delta transformer connection.

EXAMPLES

TABLE III SHOWS 27 examples of transformer-secondary-service combinations which may be termed typical contemporary and probable future practice. The single-phase or left side of the table illustrates transformer sizes from 15 to 100 kva; secondary wire sizes from no. 4 AWG (American Wire Gauge) copper to 266.8 mcm (thousand circular mils) aluminum; triplex type service drops from no. 4 to no. 1 aluminum; open type service drops from no. 6 to no. 3 copper; and secondary runs from zero to 450 feet from the transformer. On the 3-phase side of the table these are matched as nearly as possible with transformers of equal capacity and conductors of equal weight. In the preponderance of cases cited, the starting of a single-phase motor causes less lighting flicker than would the starting of a 3-phase motor.

Some companies use lighting conductors of larger size than the lighting neutral and the 3-phase power conductor, neither of which contribute to the lighting flicker caused by large motors. The variety of possible combinations is large. Allowing for such usage in selecting comparable conductor weights, flicker on the single-phase basis is still less than on the 3-phase basis in the majority of repetitive situations.

FORMULAS

THE CALCULATION of the voltage drop caused by the starting or running of a single-phase motor is quite simple. The technique used in equation 1 which follows, and illustrated in Fig. 1 differs from usual practice only in that one half of the transformer impedance is associated with conductor *B* and one-half with conductor *C*. The voltages delivered by conductors *B* and *C* have identical flicker values with respect to lighting neutral *N*. Per cent flicker is identical whether computed on 120-volt base or on 240-volt base.

The calculation of the voltage drop caused by the starting of a 3-phase motor is quite complicated, if we are interested in the flicker affecting devices served at 120 volts from a 3-phase, 4-wire, delta system. There may be only two transformers, in which case the lighting transformer may be on the lagging phase as in Fig. 2, or on the leading phase as in Fig. 3. There may be three transformers, as in Fig. 4. Regardless of transformer connections, the voltage drop to lighting neutral *N* in the secondary line and service drop has one value for the leading conductor *B* and another value for the lagging conductor *C*. Equations 2 to 7 cover these variables. The author is not aware that these equations have been developed or published heretofore.

Referring to Figs. 1, 2, 3, and 4:

R is resistance of transformer *BC*, in ohms, at 240 volt base.
X is reactance, ditto.
r is resistance of secondary and service, in ohms, one conductor.

x is reactance, ditto.
I is the locked rotor current of motor.
ϕ is the angle, in degrees, whose cosine is the power factor of I.
B and C conductors have the same impedance.
Primary voltage drop is ignored.

Referring to Fig. 1, the total voltage drop between lighting neutral N and lighting conductor C is:

$$IR/2 \cos \phi + IX/2 \sin \phi + Ir \cos \phi + Ix \sin \phi \quad (1)$$

Voltage drop N to B is the same.

Referring to Fig. 2, the total voltage drop N to C is:

$$IR/2 \cos (\phi-30) + IX/2 \sin (\phi-30) + Ir \cos (\phi-30) + Ix \sin (\phi-30) \quad (2)$$

Voltage drop N to B is:

$$IR/2 \cos (\phi-30) + IX/2 \sin (\phi-30) + Ir \cos (\phi+30) + Ix \sin (\phi+30) \quad (3)$$

Referring to Fig. 3, the total voltage drop N to C is:

$$IR/2 \cos (\phi+30) + IX/2 \sin (\phi+30) + Ir \cos (\phi-30) + Ix \sin (\phi-30) \quad (4)$$

Voltage drop N to B is:

$$IR/2 \cos (\phi+30) + IX/2 \sin (\phi+30) + Ir \cos (\phi+30) + Ix \sin (\phi+30) \quad (5)$$

Referring to Fig. 4, the total voltage drop N to C is:

$$(I/1.73)(R/2) \cos \phi + (I/1.73)(X/2) \sin \phi + Ir \cos (\phi-30) + Ix \sin (\phi-30) \quad (6)$$

Voltage drop N to B is:

$$(I/1.73)(R/2) \cos \phi + (I/1.73)(X/2) \sin \phi + Ir \cos (\phi+30) + Ix \sin (\phi+30) \quad (7)$$

CONFIRMING TESTS

BEFORE PUBLISHING these findings, it was considered advisable to make shop tests. The rotors of a 5-hp single-phase general purpose capacitor motor and of a 5-hp 3-phase general-purpose motor were locked. The motors were energized at one third normal voltage by supplying 2,400 volts to 7,200-120/240-volt transformers. The impedances of the motors and transformers were not measured.

The single-phase motor was connected to a 15-kva transformer via 100 feet of three no. 4 aluminum triplex service drop. The 3-phase motor was connected to 10- and 5-kva transformers via 100 feet of four no. 4 aluminum quadriplex service drop. Observed values of voltage drop to lighting neutral N, multipled by three, are shown in Table IV.

The shop tests were interpreted as confirming the foregoing mathematical equations and the computations in Tables I, II, and III.

Table IV. Values of Voltage Drop to Lighting Neutral N

Figure	Phases of Motor	Lighting Conductor	Flicker Volts	Remarks
1	1	B	6.6	
1	1	C	6.6	
2	3	B	6.0	Flicker in C is greater than in B. Flicker in C is greater than with single-phase motor.
2	3	C	9.0	
3	3	B	5.1	
3	3	C	8.4	

CONCLUSIONS

1. THE VOLTAGE DROP affecting 120-volt lights and television sets cannot correctly be computed on 240-volt base in the case of 3-phase motors starting or running on 120/240-volt 4-wire delta combination light and power secondary and service conductors.
2. The voltage drop affecting 120-volt lights and television sets must be calculated separately for each lighting leg using plus 30-degree phase angle correction for one leg and minus 30-degree correction for the other.
3. The error in using 240-volt base is on the order of 40 to 60 per cent for minimum size secondary and service conductors. The error is always in favor of the 3-phase system.
4. The starting of single-phase motors causes less disturbance to lights and television sets than does the starting of 3-phase motors, under situations which predominate in residential areas.
5. Finally, this new knowledge calls for the reversal of some basic concepts about the merits of single- vs 3-phase motors for residential air conditioning and heat pumping loads, and establishes an important advantage for the use of single-phase motors.

Liquid Metal Fuel Reactor

An advanced stage of a program designed for the investigation of the use of uranium dispersed in "liquid metal" to serve as a combined nuclear reactor fuel and coolant has been reached recently by the Babcock & Wilcox Company of Lynchburg, Va.

A critical assembly, operated for the Atomic Energy Commission, to help determine nuclear characteristics of a liquid metal fuel reactor system is composed of a "pile" of graphite and bismuth bars of various shapes and sizes.

The liquid metal fuel reactor concept represents a striking departure from the conventional reactor in its proposal that the fuel, highly enriched uranium metal in molten bismuth, be circulated through the reactor system.

The "ON/K" System

G. T. MASTERS
ASSOCIATE MEMBER AIEE

IN 1953, a requirement for additional circuits developed along the *K* carrier routes in Nebraska and California. Two options were available to meet these requirements.

1. Reinforce the existing plant by the addition of new basic facilities; that is, place new cable.
2. Design some means to increase the circuit capacity of the existing facilities.

After examining the problem and its economic implications, it was decided that the best solution would be to develop a means to extend the capacity of the existing plant. This article describes the *ON/K* system, which resulted from this development.

The *K* carrier system operates in the frequency band from 12 to 60 kc. The portion of the *ON* carrier system being used in this application operates in a frequency band from 68 to 136 kc. By the use of band separation filters, the two systems are operated on a single cable pair in each direction.

Ultimately, 16 additional channels will be derived from the basic facility by the use of the *ON/K* carrier system. The channels have transmission characteristics suitable for 200-mile circuits. The original systems provided only 12 channels; however, a recent change in the *ON* terminal equipment has provided 4 additional channels. In other words, by use of this carrier system, the circuit carrying capacity of the *K* carrier cable pairs has been more than doubled.

Fig. 1. ON/K terminal.

The repeater used on the *ON/K* system is one of the most interesting features of the system. It is not desirable to interset *ON/K* repeaters in the *K* repeater section. If an *ON/K* repeater were interspaced on the *K* route, this would upset the transmission characteristics of the *K* system, and would require additional repeater stations. At the frequencies of operation for the *ON/K* systems, the over-all loss of the standard *K* repeater section is approximately 100 decibels. Therefore, it is necessary to use a higher gain repeater than has been used before in telephone carrier systems. The necessary gain is provided by the use of two amplifiers in tandem. Special precautions are required to prevent crosstalk as the transmission levels are as low as 80 decibels below one milliwatt at some points in the system.

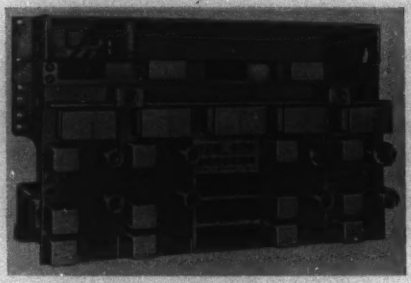


Fig. 2. ON/K repeater, mounting shelf.

The addition of the band separation filters on existing *K* carrier lines disturbs the gain frequency equalization. It is necessary to re-equalize the *K* carrier system to compensate for the filter distortion. The methods that have been used previously were slow and tedious. Therefore, a new method for re-equalizing the *K* carrier system was developed as a part of the *ON/K* program.

Increasing circuit requirements mean constant additions to the telephone plant. The *ON/K* system was developed as a result of a close examination of existing instrumentalities. This development proves that it is often possible to expand the existing facilities rather than make expensive reinforcements.

Digest of paper 58-1005, recommended by the AIEE Wire Communications Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, Sacramento, Calif., Aug 19-22, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

G. T. Masters is with the Pacific Telephone & Telegraph Company, San Francisco, Calif.

Gyromagnetic Ratio of Proton Redetermined

R. L. DRISCOLL P. L. BENDER

An extremely accurate redetermination of a fundamental physical constant—the gyromagnetic ratio of the proton—is presented. More accurate values for all physical constants whose values depend on the measurement of magnetic fields are now possible.

THE GYROMAGNETIC RATIO of the proton—a measure of its interaction with magnetic fields—has been redetermined by the National Bureau of Standards (NBS) with significant increase in accuracy. This result not only provides a better standard for magnetic fields, but also makes possible more accurate values for many of the fundamental constants of physics whose values depend upon magnetic field measurements. Examples are the electron charge-to-mass ratio e/m, the magnetic moment of the proton, and Planck's constant h.

Fig. 1. Apparatus used by the NBS to redetermine the gyromagnetic ratio of the proton, or hydrogen nucleus. The solenoid (center) whose magnetic field can be precisely calculated from its known dimensions, causes the protons in a water sample to precess with an accurately measurable frequency. The large coils which surround the apparatus counterbalance the earth's magnetic field.

The new value for the proton's gyromagnetic ratio will be especially useful in the design and development

Fig. 2. Control room at the Fredericksburg Magnetic Observatory showing equipment used to measure the precession frequency of the protons in the water sample.

of scientific and industrial apparatus in which it is important to know accurately the spatial distribution of a magnetic field or to regulate it closely. Here, the proton can be used as a very sensitive probe to determine magnetic intensity in terms of the precisely known gyromagnetic ratio. Problems of this sort arise widely in the use of scientific apparatus—cyclotrons, mass spectrographs, and beta-ray spectrometers—and in industrial equipment such as servomechanisms and electromagnets.

The present work was carried out as part of a broader program which seeks to obtain more accurate values for important constants, such as the velocity of light, the acceleration of gravity, and the various atomic constants. These constants of nature, when determined to extremely high accuracy, provide invariant bases for the reproduction of many physical quantities such as length, time, and electric current. They thus serve to lock present standards and units of physical measurement into the phenomena of science. Because the proton's gyromagnetic ratio is basic to the determination of many of these constants, it provides a connecting link between them and the accepted standards of measurement.

Like other atomic nuclei, the proton, or hydrogen nucleus, behaves as a small magnet. When placed in a

R. L. Driscoll and P. L. Bender are with the National Bureau of Standards, Washington, D. C.

magnetic field, it tends to orient its axis along the direction of the field. However, the proton is also spinning rapidly about its axis, and the resulting angular momentum causes it to act like a gyroscope. Thus, instead of lining up with the field, the proton actually precesses about the field direction. The ratio of the angular precession frequency to the magnetic field strength gives the gyromagnetic ratio.

HISTORY OF MEASUREMENT

In 1949, H. A. Thomas, R. L. Driscoll, and J. A. Hipple made the first precise measurement [1, 2] of the proton gyromagnetic ratio, using as protons the hydrogen nuclei contained in a small water sample. Their result was combined with other data to give a more precise absolute value for the proton magnetic moment

Fig. 4. Exterior of nonmagnetic building (left) used to redetermine the gyromagnetic ratio of the proton. At right is the small building in which the proton sample is first strongly magnetized. It is then shot through the connecting pneumatic tube into an accurately measured solenoid within the nonmagnetic building.

Fig. 3. Large solenoid used to provide a precisely known magnetic field about the proton sample. The field produced by the solenoid can be calculated to high accuracy from its dimensions, which are known to one part in a million. Within the solenoid may be seen coils which surround the sample and are used to measure the precession frequency.

than had previously been possible. More accurate values were also obtained for a number of the fundamental constants of physics, such as the electron charge-to-mass ratio and Planck's constant.

In the 1949 measurement, the gyromagnetic ratio was determined by measuring the magnetic field and radio frequency required for magnetic resonance absorption in the proton sample. A strong magnetic field of about 5,000 gausses was used, and its value was determined by finding the force exerted by the magnetic field on a wire carrying a known current. This magnetic field measurement was difficult and was the principal limitation on the accuracy of the result obtained.

The present method reduces the error of the earlier one by a factor of four by using simpler techniques that have been developed since 1949. In this method, the hydrogen protons in a water sample are caused to precess in a magnetic field, and the precession rate is obtained from the frequency of the voltage induced in a pickup coil surrounding the sample. The gyro-

Fig. 5. Glass sphere containing distilled water used as a proton sample by the National Bureau of Standards in redetermining the gyromagnetic ratio of the proton.

magnetic ratio is then obtained as the ratio of the angular precession frequency to the field strength.

Increased accuracy is obtained by using a magnetic field that can be calculated to very high precision. This field is produced by an accurately measured current flowing through a solenoid whose important dimensions are known to one part in a million. However, as the field strength obtained in this way is only 12 gausses, spurious magnetic fields from other apparatus, electrical currents, or vehicles must be carefully avoided. For this reason, the measurements have been carried out at the Fredericksburg Magnetic Observatory of the U. S. Coast and Geodetic Survey. The observatory is about 10 miles south of Fredericksburg, Va., on a site chosen to be as free as possible from magnetic field disturbances. A separate nonmagnetic building, with large coils for compensating the earth's magnetic field, was made available for the experiment.

Fig. 6. Compensating coils for making the magnetic field about the proton sample more homogeneous. The solenoid (*right*) has been moved aside. Above the compensating coils is the pneumatic tube used to carry the sample into the solenoid.

At this location, man-made magnetic field fluctuations are negligible and corrections for variations in the earth's field can be obtained from the observatory magnetograms.

DESCRIPTION OF METHOD

THE PROTON SAMPLE consists of distilled water contained in a glass sphere about 2 cm in diameter. The sample is placed in a strong magnetic field in order to build up a large magnetization of the protons along the direction of the magnetic field. It is then shot about 15 meters through a pneumatic tube into the center of the solenoid, within the nonmagnetic building. With the sample in the solenoid, a short pulse of r-f magnetic field near the precession frequency is applied to tip the magnetic moments of the protons so that they are left nearly perpendicular to the magnetic field direction. They then precess about the magnetic field direction at a frequency corresponding to the strength of the field. The flux through a pickup coil surrounding the sample changes at the same frequency at which the magnetization of the sample is precessing. The frequency of the induced voltage across the pick-up coil is measured accurately against standard frequency broadcasts by the NBS radio station WWV and the resulting value is combined with the magnetic field strength to give the proton gyromagnetic ratio.

Fig. 7. Precession of the proton in a magnetic field. The proton acts like a small spinning magnet with a magnetic moment as indicated by the straight arrow through its center. The applied magnetic field (*vertical arrows*) produces a torque on the proton which causes it to precess through the horizontal circle shown.

A preliminary value of $(2.67515 \pm 0.00001) \times 10^4$ radians per second per gauss, uncorrected for diamagnetism of the water sample, was obtained for the proton gyromagnetic ratio in terms of the ampere as now maintained at the Bureau. The value obtained in 1949 was given as $(2.67523 \pm 0.00006) \times 10^4$ radians per second per gauss. If the present result is combined with a recent determination[3, 4, 5] by Driscoll and Cutkosky of the ampere as maintained at the NBS in absolute units, the value becomes $(2.67513 \pm 0.00002) \times 10^4$ radians per second per gauss.

REFERENCES

1. Measurement of the Proton Moment in Absolute Units, H. A. Thomas, R. L. Driscoll, J. A. Hipple. *Journal of Research*, NBS 44, 569, RP2104. National Bureau of Standards, Washington, D.C., 1950.

2. Magnetic Moment of the Proton. NBS Technical News Bulletin 33, 57, *Ibid.* May 1949.

3. Measurement of Current with the NBS Current Balance, R. L. Driscoll, R. D. Cutkosky. *Journal of Research*, NBS 60, 4, RP2846, *Ibid.* 1958.

4. Measurement of Current with a Pellat Type Electrodynamometer, R. L. Driscoll. *Journal of Research*, NBS 60, 4, RP2845, *Ibid.* 1958.

5. Redetermination of the Standard Ampere, NBS Technical News Bulletin 42, *Ibid.* Feb. 1958.

Water Cooling of Turbine–Generator Strator Windings

G. V. BROWNING C. H. HOLLEY J. F. QUINLAN
MEMBER AIEE

THIS ARTICLE presents the results of engineering and laboratory studies on the use of water as a coolant for direct cooling of the copper conductors of turbine–generator stator windings. Table I compares the relative rates of heat removal by several fluids under similar conditions that are practical for employment in turbine–generators.

Table I. Relative Heat Removal Ability of Coolants

Air	1.0
Hydrogen 30 psi	3.0
Transil Oil	21.0
Water	50.0

This table emphasizes the superiority of liquids as heat removal agents and points out the advantages of water over transil oil which has already been employed. In view of the advantages of water, work was started early in the development of liquid cooling to evaluate its properties under the conditions obtaining in a generator application.

The superior heat-removal ability of water makes possible larger kva ratings of generators than can be obtained with oil-cooled windings. Even with such larger ratings, high generator efficiencies can be maintained as less cooling space within the conductors is required by the design for water. Therefore, more space is available for the conductors and copper losses can be kept to a minimum. The temperature rise of the coolant will be less with water, providing a lower and more constant winding temperature and, therefore, minimizing thermal expansion effects on the stator high-voltage insulation. Water, of course, has additional desirable properties, including chemical inertness to insulation, low cost, good availability, and its nonflammable character.

Fig. 1. Typical laboratory simulative test loops for water-cooled stator windings.

There were a number of uncertainties about the suitability of water for cooling the conductors of high-voltage stator windings. Questions such as the following needed to be answered:

1. Is the electrical resistivity of high-purity water good enough for generator application with adequate margin against flashover through or along the connection hoses?
2. Is it practicably possible to maintain water at a high purity while it is being circulated through a generator winding and exterior auxiliary equipment?
3. With water cooling, would there be significant corrosion and erosion of the copper conductors and other materials in the cooling system?

To evaluate the various factors in relation to projected generator operation, test equipment consisting of four different kinds of test setups was constructed. The objective was to obtain information concerning the properties of relatively pure water contained in a metal system, under the influence of high voltage and current and the effects of the interaction of such water with the materials of the system. In addition, the use of additives to meet freezing conditions of outdoor stations was considered. Fig. 1 shows one of the four kinds of setups in which long time data was obtained.

Full-scale flashover tests were also made to determine the effects of various levels of water purities on the liquid connections and stator end windings.

From assessment of the results of the work described the following conclusions have been reached:

1. Water as a coolant for large turbine-generators has several advantages: (a) Its outstandingly good heat-removal ability will result in even cooler windings than are obtained with oil cooling in present ratings and will make possible much larger ratings in the future; and (b) It is nonflammable and universally available.
2. Suspected disadvantages, such as lower resistivity and corrosive–erosive effects, have been shown in extensive laboratory tests to be of no particular significance.
3. Maintenance of water with sufficiently high purity is readily accomplished using the type of deionizing equipment which is well known in the industry.
4. Water cooling now seems entirely practical and desirable for large turbine–generators.
5. Future possible advantages include the use of condensate as a winding coolant with perhaps some slight improvement in station heat rate.

Digest of paper 58-278, recommended by the AIEE Rotating Machinery Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

G. V. Browning, C. H. Holley, and J. F. Quinlan are with the General Electric Company, Schenectady, N. Y.

Application of Shift Register Techniques to Materials Handling

H. C. DIENER, JR.
ASSOCIATE MEMBER AIEE

Shift registers, when composed of static elements, combine flexibility and reliability in performing control functions for industrial materials handling systems. Circuit configurations and field applications are described for dispatching, scanning, counting, and static stepping switch functions.

THE TERM "shift register" is well known to those familiar with digital computer circuitry.[1] However, today it is finding wide application in static type industrial control systems as well. Evans, Hall, and Van Nice have described industrial type magnetic circuits for performing the basic English logic functions of AND, OR, NOT, MEMORY, and DELAY.[2] The shift register circuit applications described herein are composed of

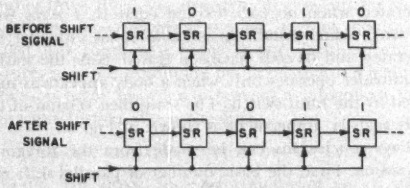


Fig. 1. Illustration of the shift register functions.

this magnetic logic system. Such systems and logic elements, employing the Ramey magnetic amplifier principle, are commercially available under trade name of CYPAK.[3] However, the principles to be described are sufficiently general to apply to other forms of static control as well.

Fig. 1 illustrates the basic shift register function. Here are shown five shift register stages in cascade. Using conventional binary notation, the numeral one designating ON and the numeral zero designating OFF, the five stages are arbitrarily assumed to be in the states indicated on the top line. The shift register stage has the characteristic of assuming the state of the preceding stage after the appearance of a shift signal. Thus, after the appearance of a shift signal, the state of the various shift register stages appears as shown on the lower line of Fig. 1. In effect, the shift signal has moved the stored information one stage to the right.

Essentially full text of paper 58-1166, "The Application of Shift Register Techniques to Materials Handling," recommended by the AIEE Industrial Control Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Scheduled for publication in AIEE *Applications and Industry*, 1958.

H. C. Diener, Jr. is with the Westinghouse Electric Corp., Buffalo, N. Y.

BASIC SHIFT REGISTER COMPOSITION

BEFORE A DESCRIPTION of the detailed features and applications of the various configurations, a word is in order regarding the basic composition of shift registers. Fig. 2 shows a group of logic elements arranged to perform the shift register function.

Note that the basic function is composed of a NOT element, two MEMORY elements and two AND elements. The first MEMORY denoted "Memory A" defines the state of the shift register stage.

Assume "Memory A" is ON. Then momentary appearance of the shift signal causes AND "A" to have both its inputs present and, hence, to produce an output. This output turns "Memory B" ON. "Memory B," in turn, turns "Memory A" OFF. The ON signal from "Memory A" has now been completely shifted to "Memory B" where it remains as long as the shift signal is present.

When the shift signal disappears, the NOT element puts out a signal to AND "B." This causes the information in "Memory B" to be shifted to "Memory A" of the succeeding stage in a manner similar to the shifting from A to B just described.

Numerous variations of the foregoing configuration exist. For example, the output of a single NOT element may be used as the input to AND "B" for several stages. Thus, the NOT need not be part of each stage. In another variation, a sequence of signals appears to cause the shifting and the resetting of the "Memories," instead of having these functions performed internally as shown. Although some shift register circuits are not made explicitly of the logic elements as shown, the logic functions themselves are inherent within them. Thus, the actual circuitry is often simpler than that implied by Fig. 2.

ARRANGEMENT FOR MATERIAL DISPATCHING

WITH THIS REVIEW of shift register operation, it follows that information can be moved through a control system in synchronism with material being transported in a materials handling system. For example, coded information can be introduced into a control at the time material enters a conveyor. Such information could determine where the material is to be unloaded or what processes are to be performed upon it. As the material passes along the conveyor, the information advances

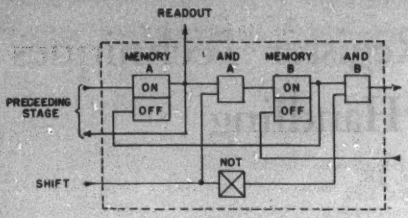


Fig. 2. Composition of shift register stage from standard English logic functions.

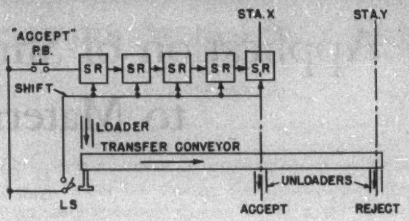


Fig. 3. Simple dispatching system involving only two destinations.

through the control. This is accomplished by causing the conveyor drive to deliver a shift pulse each time the conveyor has advanced a certain distance. When the material arrives at a point on the conveyor where the desired process is to be performed, the information arrives at a corresponding point within the control to permit the initiation of the process.

Fig. 3 shows a simple dispatching system involving only two destinations. Here the material is loaded onto a transfer conveyor by a loader shown at the extreme left. At the time the material is loaded, it is inspected by an operator. If the material is acceptable, the operator presses the "accept" pushbutton. If it is rejected, the operator presses no buttons. Accepted material is to be unloaded at station *X*. Rejected material is to be unloaded at station *Y*. The pressing of the accept pushbutton turned on the first shift register stage, that is, it introduced a numeral one into the system. This numeral one advances through the cascaded shift register stages as the material advances along the transfer. Note the limit switch *LS* which provides a shift signal for each transfer index or movement over a preset distance. When the material arrives at station *X*, the numeral one arrives at the shift register stage corresponding to station *X* and initiates the station *X* unloader. If the material was rejected, no numeral one would be introduced, and a numeral zero would have been passed along through the control. Since the numeral zero will not initiate the station *X* unloader operation, rejected material passes to the end of the transfer, where it is unloaded at station *Y*. Thus, the single line of cascaded shift register stages permits two possible choices of material destination.

Applying the binary coding principle, parallel lines of shift register stages in cascade can be used to increase the number of choices. This is illustrated by the system shown in Fig. 4. Here 16 possible choices exist as shown by unloading stations A through P. Sixteen dispatch pushbuttons would be used to provide the 16 possible choices. Each pushbutton would introduce one of 16 possible codes into the 4 parallel lines of shift register stages shown. The 16 codes are shown immediately beneath the parallel shift register stages at each station on Fig. 4.

The arrangement shown in Fig. 4 can be somewhat simplified. Such simplification is done by causing operation of an unloader to reset (that is, erase information from) the single parallel group of shift register stages which initiated its operation. A code of 4 zeros thus appears in a stage after its unloader has operated.

Note in Fig. 4 that the fourth line of the shift register needs only to transmit zeros beyond station *H*. Similarly, the third line need only transmit zeros beyond station *L*. The second line need only transmit zeros beyond station *N*. And the first line need transmit only zeros into station *P*. Since a choice does not, in fact, exist between numeral one and numeral zero in these stages, they may be removed. A limit switch, or other detecting device, can now be used for the initiation of operation of the unloader at station *P*. Station *P* unloader previously operated when no code existed (that is, 4 zeros were present), which condition exists after an unloader has operated and its code has been erased. Now the station *P* unloader operates only when a body appears as indicated by the limit switch. The simplified version of the shift register arangement is shown in Fig. 5.

Two conclusions can be made from the foregoing discussion. First, the basic number of parallel shift register lines required is equal to the number of binary digits required for representing the number of choices. Second, by erasing the code after each actual operation, this number is reduced to that required for the remaining choices only.

A complementary condition exists for a material loading scheme based upon similar premises. Assume that a transfer conveyor exists upon which material is to be loaded as directed by an operator or another part of

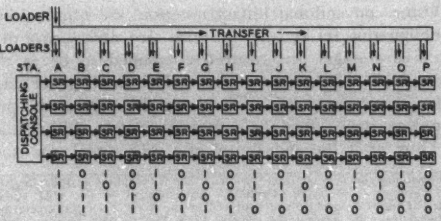


Fig. 4. Dispatching system involving 16 destinations.

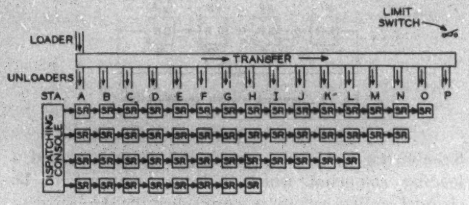


Fig. 5. Simplification of parallel shift register arrangement.

the control system (Fig. 6). A code of 4 zeros thus appears in a stage after its unloader has operated. It is desired to load this material in some particular order from 16 possible sources. As consecutive spaces appear at the head end of the transfer conveyor, the dispatcher, whether human or mechanical, indicates from which of the 16 sources material is to be loaded. When that particular space is moved adjacent to the proper source, material is then loaded. A similar coding system can be used as was used in the unloading arrangement. However, here it is possible that by the time a space arrives at a particular point to be loaded, the supply of material may have been exhausted. Anticipation of such a condition is difficult since the backlog of orders already in the system for a given source may vary.

In this case, the additional logic elements shown in Fig. 7 are introduced. When reducing the number of parallel lines, this logic arrangement prevents the shifting of any numeral ones if the last stage of the discontinued line contains a numeral one. In this form of erasure, it is not absolutely necessary that a scheduled operation occur in order to prevent a subsequent false operation further down the line.

ACTUAL EIELD APPLICATION OF DISPATCHING

BESIDE THE USUAL HIGH RELIABILITY of an all static system, the shift register dispatching means provides the ultimate in flexibility. All of the stored information is available at all times in a form compatible with the various sequential functions. Such high flexibility is very desirable in the automotive industry or in other industries where interruption of a process might result in tremendous losses. In addition to demanding high reliability, high flexibility is desired in order that the operator have wide latitude in the event of mechanical breakdown. Such systems are designed to provide the highest performance possible on the remainder of the system in the event one section is disabled.

Fig. 8 shows a plan schematic of a conveyor system employing the described shift register dispatching techniques. Bodies are loaded on the loading transfer by means of the loader shown at the lower left. At the time of their loading, the operator dispatches each body to one of 15 storage conveyors. This dispatching is based on body style, color of paint, and the type trim. Thus, the conveyor system functions both as a storage means and as a sorting means.

Bodies are unloaded from the storage conveyors onto the unloading transfer as commanded by the console at the upper right. The bodies are withdrawn in an order conducive to economical production operations. Thus, the complete conveyor system serves to sort the bodies so that economical production runs can be made. Both transfers are indexing type.

In order to prevent overloading any one storage conveyor, a differential counter is provided for each storage conveyor. This counter adds one at the time the body is loaded on the loading transfer when the loading dispatch command is given. It subtracts one when a body is loaded from the given storage conveyor to the unloading transfer. Thus, the counter maintains a net count of all bodies actually on a storage conveyor or enroute to that storage conveyor. It is so interlocked that further dispatching cannot be made if a certain maximum net count is reached.

The preceding paragraphs describe the basic operation of this system. However, besides providing the automatic dispatching, the system permits the operator to change his mind and reroute material that has already been dispatched. For example, assume that for some reason no additional material is to be dispatched into storage conveyor no. 12. The operator may or may not remember the destinations of all bodies on the loading transfer between the loader and station 12. Nevertheless, he can clear previously dispatched orders, one by one, for the material in this zone. He can manually initiate unloading of any body when it comes adjacent to a desired unloader. The system is so flexible that he may thus erase orders for any one body, any group of bodies, or all bodies in this zone. Regardless of his action, correct tallies are maintained on all differential counters affected.

The maintenance of correct tallies on the differential counters is accomplished in the following fashion. Assume that a body at station 6 on the loading transfer is to have its order cleared. Further assume that the order was for the loading of the storage conveyor no. 12. The operator shifts a selector switch from "Automatic" to

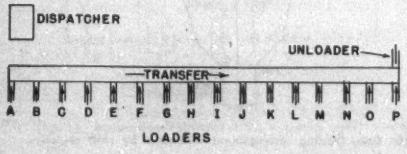


Fig. 6. Material loading system.

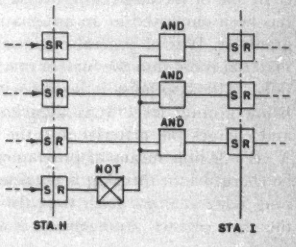


Fig. 7. Method of erasure used with loading system.

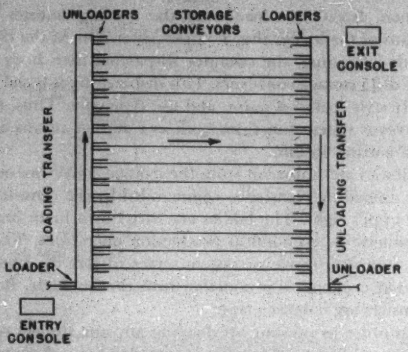


Fig. 8. Plan of actual field application.

"Clear," and presses the dispatch button corresponding to the position where the body in question is now located. When the button is pressed, the code is broadcast over common signal busses to all differential counters. Subtraction is made on the differential counter for which the code applies. In this case, it would be a subtraction from the counter of storage conveyor no. 12. When the body is advanced to an alternate conveyor onto which it may be loaded, the operator sets his selector switch to "Manual" and now the dispatch buttons may be pressed corresponding to the conveyor onto which the body is to be loaded. If, for example, this were conveyor no. 8, the differential counter for conveyor no. 8 would be advanced one count.

Where system flexibility is needed, as just described, shift register techniques apply remarkably well.

STEPPING SWITCH CONFIGURATION APPLICATION

FIG. 9 shows another important configuration. Here several shift register stages are cascaded as previously described. Unlike the previous system, however, the first stage is cascaded directly behind the last stage so that a closed ring exists. Initially, all stages are turned OFF (0) except one. This one stage is turned ON (1). The numeral one, or ON state, is thus shifted from stage to stage each time the shift signal appears. Thus, it continues to travel around the ring. It is seen that this is analogous to stepping switch operation. Minor modifications of this method permit the shift register to be applied to scanning and counting functions as well.

Several field applications employing this technique can now be cited.

In one of the large eastern steel mills, this technique has been employed in an automatic blast furnace programmer. It is of general engineering knowledge that material is fed into the blast furnace by means of a skip hoist. The skip hoist is loaded with material in a pit below ground level. It is then hoisted up an incline and charges the material into the top of the furnace. A very flexible means of programming the material to be charged into this skip is obtained by using the stepping relay analogy. Each time the skip enters the pit, the shift register arrangement is advanced one stage.

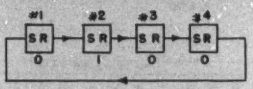


Fig. 9. Stepping switch configuration.

Suitable logic elements permit the control to read a loading command which indicates material to be charged on that particular load. When the skip car next returns to the pit, the shift register has advanced one stage and the command for that load is now read. It is quite possible to reset the configuration back to stage no. 1 at any point in the cycle by previous programming. Programming is accomplished by means of a battery of selector switches. In the particular application, it is possible to have from 1 to 10 skips programmed on a repeating basis as desired. In fact two programs of up to 10 skips each may be set up simultaneously, and the system will follow either exclusively or both consecutively.

Shift register techniques in the stepping mode are also applied on this same control to select one of a group of coke bins that are to be used to supply coke. Fig. 10 shows the arrangement of feeding coke. Coke is fed into the car first from the right side and then from the left side on consecutive skips. The weigh hopper on the left is refilled from one of three bins, nos. 1, 2, or 3. Normally, it is refilled from a different bin on each consecutive refill. However, it is very simple to eliminate any one bin or any group of bins from the program simply by switching the undesired bin OFF. The shift register circuit is arranged so that it will search for a bin that is ON, passing up all of those that are OFF. Thus, the system scans the bins and selects a suitable one (in this case, one that is turned ON).

Fig. 11 illustrates an application employing the stepping principle in the automotive industry. An indexing transfer conveyor is shown receiving material from one of five storage conveyors. It is desired to remove 10 bodies each from the various storage conveyors in consecutive order. To accomplish this, a counter which provides a signal at the count of 10 is used for advancing the shift registers. Thus, the ON signal (or numerical 1) advances along the upper row of shift register stages from no. 1 to no. 2 to no. 3 to no. 4 to no. 5. At sta-

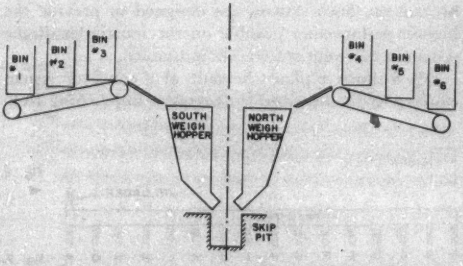


Fig. 10. Coke feeding arrangement controlled by shift registers.

tion no. 5, it is desirable next to shift back to station no. 1. However, all bodies on the transfer must be cleared. Therefore, the shift back to station no. 1 is accomplished by means of the lower row of shift register stages. This row, however, must be shifted by means of the index transfer.

USING SHIFT REGISTERS IN COUNTING

It is obvious from the aforementioned points that the shift register can be used as a basic counting element. Fig. 12 shows a basic scale-of-two, or binary, counter composed of two shift register stages. By making the pulse to be counted the shift pulse, this circuit will shift back and forth alternately as the shift pulses are received. If a signal from one of the two stages is now used as a shift pulse for another similar circuit, this system could be used to count to four. By cascading additional pairs, a binary counter of any desired capacity can be composed. Quite often, in the interest of economy, it is desirable to combine this scale-of-two stage with a scale-of-three, a scale-of-four, or other combination to provide a low capacity counter.

SUMMARY

The foregoing illustrations have presented the shift register as a performer of the following functions:

1. Information dispatching
2. Stepping switch and scanning
3. Counting

High versatility has been achieved in most cases by providing alternate signals for shifting in addition to the main shift signal. Because shift register circuits are available that are compatible with industrial-type magnetic elements, they can be incorporated directly into industrial control schemes. A chief advantage of magnetic shift registers over some other types, such as transistors, is their ability to retain information intact even through a power failure. Thus, on any of the dispatching systems described, operation can be easily resumed immediately upon restoration of power.

Although the conveyor field installation described apply to the sorting and storage of material, the techniques are just as easily used in manufacturing proc-

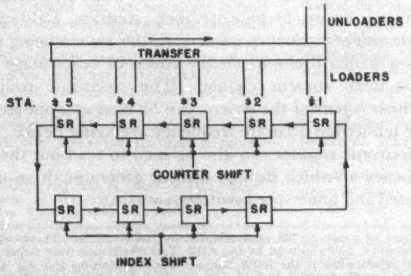
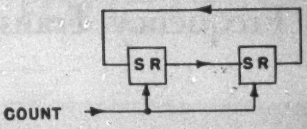


Fig. 11. Automotive conveyor using stepping switch configuration.

Fig. 12. Scale-of-two counter.



esses. For example, assume a manufacturer desired to use one punching and stamping line for several different models of television chassis which he makes. The various chassis might be made by different combinations of operations in the line. By coding the blanks as they enter the line, the various operations could be indicated in much the same manner as that described for loading and unloading. Successful field application of shift registers to lines containing diverging and converging branches has been achieved. This permits the paralleling of slow operations so that over-all line speed may be maintained.

The high versatility and flexibility provided by shift registers will be counted upon increasingly by industrial control designers in the future. As a system component, it promises to have at the least as bright a future in industrial control as it has enjoyed in the field of data processing.

REFERENCES

1. Digital Computer Components and Circuits (book), R. K. Richards. D. Van Nostrand Co., Inc., Princeton, N. J., 1957.

2. Magnetic Logic Circuits for Industrial Control Systems, W. G. Evans, W. G. Hall, R. I. Van Nice. AIEE *Transactions*, vol. 75, pt. II, 1956, pp. 166-71

3. The Single-Core Magnetic Amplifier as a Computer Element, R. A. Ramey. AIEE *Transactions*, vol. 71, pt. I, 1952 (Jan. 1953 section), pp. 442-46.

Light Bulbs without Light

Few persons are aware that several million bulbs are produced which give no light at all or which are not used to see by. According to E. G. F. Arnott, director of research for the Westinghouse Lamp Division, Bloomfield, N. J., these dark lamps perform such varied tasks as keeping food fresh, helping to capture criminals, detecting and preventing disease, etc.

Among these weird bulbs is a rapidly enlarging group of lamps known as "ultraviolet radiators." These lamps emit an invisible kind of light. The vibrations they produce are so rapid and the wave length so short, that the human eye cannot "tune in" on them. Included in this strange group are "black light" lamps. Most of these use mercury vapor and argon gas within a special glass tube or bulb. After all visible light has been filtered out or absorbed, the remaining ultraviolet radiation is capable of producing fluorescence or phosphorescence in certain substances.

Also in the ultraviolet group are those tremendously potent lamps, Sterilamps or germicidal units, whose invisible light protects against many diseases.

Frequency Transient Measurements in Power Systems

G. N. SWANSTROM

A RECENTLY developed frequency transient magnitude measuring system measures, accurately and conveniently with digital read out, the magnitude of frequency transients in power systems. It is not affected by the variables which normally produce inaccuracies in other frequency transient measuring systems.

The system consists of a frequency discriminator, a direct coupled amplifier, a peak transient trigger, an electronic frequency-period counter and either an ink-writing or photographic oscillograph. Fig. 1 shows the block diagram and typical voltage waveforms for the system. The frequency discriminator is connected to a 400 cps (cycles per second) bus where the frequency transient to be measured occurs. A voltage analog of frequency produced at the output of the frequency discriminator is amplified by the direct coupled amplifier. After amplification, the voltage analog of frequency is fed to the peak transient trigger and to the oscillograph. When the true peak of the transient occurs, the peak transient trigger senses zero slope and sends a pulse to the electronic frequency-period counter. The counter adjustments are set for a single period measurement and connections are made so that a signal is received from the 400 cps bus. At the instant the counter receives the pulse, it resets and then measures the period of the next voltage wave on the 400 cps bus. When the counter starts counting, it displays a gate pulse on the oscillograph. By oscillographic comparison of the time of the gate pulse and the time when the peak of the transient occurred, timing of the counter trigger may be readily checked. The counter holds the period measurement until another reset pulse is presented or until it is manually reset.

Fig. 2 demonstrates the ability of the system to make measurements at the peak of transients with different transient rise times. Table I is a tabulation of frequency transient magnitude data taken with different amounts of step load applications on a 40 kva, 400 cps, synchronous generator driven by a hydromechanical constant speed drive. By repeating each load application and slightly changing the timing of the gate pulse with respect to the peak of the transient, it is possible to eliminate any timing error and reduce the over-all maximum errors shown to less than 0.16 cps.

Table I.

Load Application Per Cent of Full Load	Indicated Peak Value of Transient cps	Maximum Error cps
25	396.8	0.17
50	392.9	0.20
100	385.1	0.30
150	378.2	0.37
200	371.1	0.43

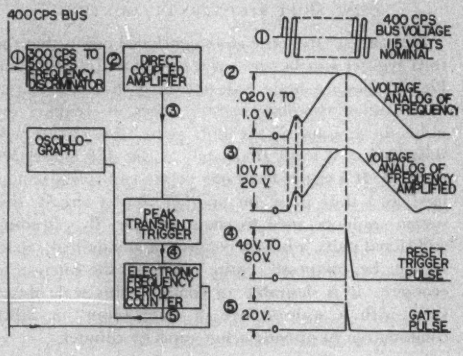


Fig. 1. Accurate frequency transient magnitude measuring system.

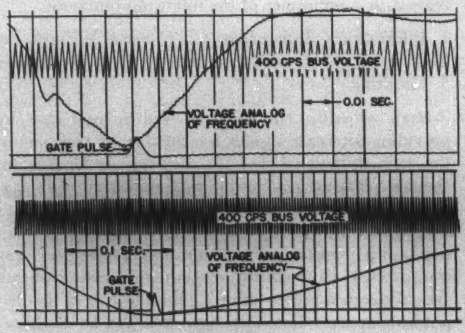


Fig. 2. Oscillograms—gate pulse timing.

The system is useful in the laboratory as an accurate power frequency transient magnitude measuring device. It can be used in conjunction with other transient frequency meters to improve their accuracy. Calibrating a transient frequency meter with this system being used as a standard eliminates the effects of bus voltage and harmonic content changes. The electronic counter, which is part of the system, can be used as a one-second or ten-second accurate frequency averaging device. The electronic counter can also be used to read out the frequency at which devices such as generator drive overspeed and underspeed switches actuate.

Digest of paper 58-788 recommended by the AIEE Air Transportation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, New York, June 22-27, 1958. Scheduled for publication in AIEE *Applications and Industry*, 1958.

G. N. Swanstrom is with the Sundstrand Machine Tool Company, Rockford, Ill.

ELECTRICAL ENGINEERING EDUCATION

AIEE in Iowa State College

THE AIEE Student Branch at Iowa State College, Ames, Iowa, was authorized on April 15, 1903. Present Counselor is W. L. Hughes, (AM '56), assistant professor of electrical engineering.

The Division of Engineering at Iowa State College was organized about 1896 with four departments. It now has 11 degree-granting departments, an Engineering Experiment Station and an Engineering Extension Service.

The Electrical Engineering Building (*right*) was completed in 1952.

A New Approach to Training Telephone Engineers

W. C. BURNETT
MEMBER AIEE

L. C. ADAMS

A PICTURE of telephone engineers living in a college dormitory, eating in a college dining hall, and walking across a campus to classes on communications theory conducted by college professors is an intriguing one. This has been taking place during the past year in South Carolina. It is part of a new method of providing technical training to experienced telephone engineers developed by the School of Engineering of Clemson College and the engineering department of the Southern Bell Telephone and Telegraph Company.

Origin

This school had its beginning in two separate but related events. The Southern Bell Telephone and Telegraph Company recognized that it needed a survey of the needs for training in its engineering department. To this end a study was made during the summer of 1956 by a college professor, whose assignment was to explore the needs for training telephone company engineers and the training program as it existed, and to make recommendations for a comprehensive training program. Frequent contact was made with the training people of the engineering department, and trips were made into the operating areas to interview engineers at all levels. The study revealed that the company had a shortage of engineers who might be available as instructors in telephone training courses. As a result, one suggestion was that it might be possible to make use of professional instruction, that is, teachers from college engineering departments.

During the same summer, the transmission engineers of the company met to discuss their needs, and found that one of their greatest was specialized training in telephone transmission engineering for their people. When this was discussed with the personnel of the training section, it was pointed out that prior commitments would make it impossible for a transmission engineering school to be conducted before 1958. The transmission engineers were completely dissatisfied with this situation. The need for early training was urgent.

There were two reasons for this urgency. It had been many years since the company had conducted any sort of transmission school, and during this time many new people had come into the transmission sections. But of greater importance was the expected effect of the vast changes that are taking place in the telephone communications industry. In very recent years, the industry has begun to provide a multitude of new types and kinds of services that people and business want and need in this rapidly changing world. In the past, the Bell Telephone System has generally followed a system of engineering that begins in the Bell Telephone Laboratories, where basic research is done. General application engineering is a major activity of the operation and engineering department of the American Telephone & Telegraph Company. It is here that Bell System engineering practices are prepared. These are distributed to all the operating companies which, in turn, use them in their local application engineering. When special problems arose or new and different communications services were proposed, these matters were frequently referred by local area engineers to their headquarters and often to the operations and engineering department in New York City.

Recently the Southern Bell Company decentralized practically all engineering to the nine state areas, which now develop solutions to the special problems and design facilities to care for new and different services. As a consequence, the work of the transmission engineers in the state areas is greatly more complex and carries far more responsibility. Therefore, their staffs require more thorough training than before.

Another consideration was the nature of the training which the transmission engineers desired for their staffs. From the late 20's through the 40's the Southern Bell transmission schools had combined theory with application, making use of equipment and circuits that were in common use throughout the Bell System. Students came from both engineering and operating departments, and the

Essentially full text of paper 58-1152, recommended by the AIEE Wire Communication Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958.

W. C. Burnett is with the Southern Bell Telephone and Telegraph Company, Birmingham, Ala., and L. C. Adams is with Clemson College, Clemson, S. C.

Electrical Engineering Education

engineering emphasis was on application rather than fundamental principles. Recognizing that basic knowledge is of greater value to the design engineer than is application knowledge, the transmission engineers wanted training to stress the underlying theories of communication circuit design. It was felt that not only would the basic theory be remembered better and longer, but also it would better equip an engineer to tackle and solve the problems of providing new and different communications services.

Further discussion by the transmission and training groups resulted in a proposal to combine the need for early training with a suggestion that college instructors present courses for a telephone school. Because much of the training desired would be basic and of a theoretical nature, it was clear that professional instructors could do this teaching better than telephone engineers.

Overtures were made to Clemson College in South Carolina, and a favorable response was received. Then the transmission engineers established a steering committee to organize the broad aspects of the training course desired, and an outline was presented to the college. Details were developed in joint discussions between the college staff and telephone company engineers. Both groups became enthusiastic about the possibilities of operating a school of the type desired.

The college regards this program of instruction as an industrially supported engineering extension service. Clemson has, for many years, conducted short courses for agricultural groups. Thus, the administration readily accepted the program. This was an opportunity to serve southern industry and, at the same time, to bring about an association with benefits accruing to both company and college. Final acceptance of the idea rested with the electrical engineering faculty. This group adopted the program in a formal meeting without a dissenting vote. Five members of the staff requested a part in the project and others offered to serve if needed.

Advantages of a Campus-Type School

A major advantage of the Clemson plan is the use of professional teaching. It is logical that those persons experienced in teaching will do a better job than those whose life work is applied engineering. The ability of a man to design or to solve engineering problems does not necessarily equip him to explain them. Thus, many excellent engineers are poor teachers. Furthermore, it is felt that company instructors probably would not cover in the allotted time as much ground as do the professors; the company instructors might wander off the highway of theory onto the interesting byways of telephone application and personal experiences.

Another major advantage comes from having students in an environment that is conducive to study and learning. Thus, housing telephone students in a dormitory, feeding them in a college dining hall, and assembling them in regular classrooms provide atmosphere and climate that are in very favorable contrast to former arrangements of holding schools in city hotels, which are inherently surrounded by interesting, but time-consuming, diversions.

Further, there accrues a net saving in engineering manpower because professional teachers can teach fundamentals with less added work than can company instructors.

Course of Instruction

In August 1956, the company's transmission engineers chose a steering committee composed of five transmission engineers, with the engineering training supervisor as an ex officio member.

From the beginning, it was intended that this school would be basically fundamental. As stated previously, it was believed that in the long run engineers would obtain the most benefit from training in fundamentals. Consequently theory, rather than application, has been emphasized.

The school has been divided into four courses, each of which covers a major subject or grouping of subjects. The first course ran 3 weeks; each of the other three are 2 weeks in length. Each course is repeated as many times as needed to accommodate the number of students to be sent. The company regards this arrangement as superior to previous similar schools which the student attended continuously for about 8 weeks.

In the first place, this plan promotes efficiency, in that once the teaching staff has prepared work for a course, it can present the material every 2, 3, or 4 weeks with a minimum amount of time for review of the lesson plan. Second, the absence of an engineer from his desk for periods of 2 weeks each is far less disrupting to production than is a single absence of 9 weeks. Furthermore, most of the men are much happier if they are not away from home for extended periods. Finally, the divided plan provides desirable flexibility in scheduling the students for those courses which they most need. Some men will take all courses while others may require only one.

The first course (3 weeks) covers basic transmission theory, including acoustics, transmission lines, and active elements. The second course (2 weeks) deals with the theory of low-frequency and voice-frequency induction, protection, and corrosion. In the third course, also 2 weeks, the subjects are crosstalk and carrier transmission. The final 2-week course embraces the fundamentals of radio. An outline of the subjects is given in Appendix A.

It was mentioned previously that this school is charged with teaching the basic theory of telephone communications. The application training which should follow has been made a responsibility of the nine state areas. The depth and breadth of this application training will vary according to the needs of the engineers in each area.

Using material furnished by the transmission engineers, the professors prepared their own lectures and lesson plans. Quite naturally, the nature of material furnished by the company varied with the subject. For instance, the subjects of acoustics, transmission lines, and active networks are generally familiar to an electrical engineering teaching staff. The steering committee and representatives of the college developed the course outline. The individual professors in the electrical engineering department then completed the preparation.

Without recourse to telephone material or reference to telephone company problems in this field, a professor in the chemistry department prepared and taught an excellent course on the theory of corrosion. On the other hand, telephone engineers who are specialists in these subjects prepared detailed lectures for the course on crosstalk theory, transposition theory, and transposition design.

Because of our firm conviction that the quality of teaching by professionals is very much the better, to the maximum practical extent teaching is being done by members of the college faculty. However, where the subject is completely unfamiliar to the faculty, telephone engineers who are considered to be suitable teachers take over the assignment. Most theory is taken by the college faculty, while those application subjects that are peculiar to the communications business become the responsibility of telephone engineers. About 85% of the classroom hours are taught by the professors.

The amount of time spent in classroom work is based upon the schedule of a typical undergraduate engineering student. This amounts to about 24 contact hours per week. Although the volume of subject matter covered is considerable, it is not deemed practical from any point of view to hold the students in formal session for more than 20 to 24 hours each week. Furthermore, homework reading and problem assignments require from 1 to 2 hours' out-of-class study per contact hour.

A course consists of several independent subjects, each of which is assigned to a different teacher. Thus, the overload on any one staff member is held to a safe minimum. Once the subject breakdown is made, scheduling the program is no great problem. Participants indicate the hours available and their preference of hours for subject offerings. As a result, the schedule literally adjusts itself to an even spread throughout the week.

Most of the textbooks being used are standard technical books. Some are provided on the basis of one for each student, whereas others are made available in several copies for reference use. The texts have been supplemented by Bell System Practices, Bell Telephone Monographs, and other suitable material.

Usually, the teacher furnishes to the students handouts consisting of lesson plans and other pertinent material. These promote efficiency in teaching and learning, and they provide references for the engineers after they return to their jobs.

In Appendix B is a list of the textbooks

which are being used in the school. The steering committee has recommended that the transmission sections in the state areas build up their technical libraries with many of these texts.

In the interest of conserving time, no laboratory work is included in the course, but demonstrations are used to emphasize certain theory.

The faculty instructors do not feel that it is fair either to the short-course student or to the college to grade the men taking the course. They are not on the campus long enough for this. However, the company wishes to know which of its engineers excel in fundamental theory, so two grades are given. All participants receive a grade of S (satisfactory) except a small percentage who do exceptionally good work. These receive a grade of E (excellent). The company is furnished no further grading information. Grades are based upon homework papers and a series of quizzes given during the course.

Students

The subject material has been pitched at the college senior and graduate level. Therefore, the general student qualification is that he should be an electrical engineering graduate or possess equivalent theoretical background. Equivalence could be attained by a college or high school graduate who has had considerable technical experience, informal education, and training within the company.

The original intent was to provide advanced training for transmission engineers and for engineers who were good prospects for transmission work. Then it was decided to open the door as well to transmission maintenance personnel from the plant department.

No tests are given to prospective students. Rather, they are chosen by the state areas on the basis of their formal education, company training, telephone experience, present duties, and ability to absorb high-level training. We believe that generally good choices have been made.

Several weeks prior to his attendance at a semester of schooling, each student is sent a textbook and other material for advance study. This enables him to determine what reviewing he needs to do and to acquire some familiarity with the text. In turn, this promotes efficiency in learning while he is at Clemson.

Mechanics

Telephone Company students are housed in a dormitory that has always been used for short-course groups. During the last five years, Clemson has erected new housing which has been more than adequate for her growing body of about 4,000 resident students. Thus, the housing officer has made a block of 25 rooms available to the telephone school for its duration, or until such time as they are needed for the student body.

Clemson students eat, family style, in a single tremendous dining hall. Normally, a boarding student pays for room and board at the beginning of the semester and is admitted to the dining room upon identification by card. Short-course students are accommodated in the same way. The cost per student is slightly greater to allow for maid and linen service, a service not available to the undergraduate resident.

Evaluation

Student reaction must be considered in the light of the intent of the school, which is to provide high-level training in the basic theories of communications circuits and components. Many of the students have come away from a 2- or 3-week session feeling that they had been swept up onto a cloud and left there, unable to pierce the fogs and mists of theory and see the everyday job back on earth. This is neither an unexpected development nor one that causes us concern. The planners of the Clemson school wanted major emphasis on basic theory and intended that the state areas would carry out suitable application training. As an example of this, the Alabama area will hold, upon the completion of the current semester of the Clemson school, a 3-day seminar in which applications will be discussed. This seminar will be attended by all of the Alabama engineers who have been enrolled in the Clemson program. By this means, the training of engineers will be made more nearly complete.

After a good look at the Southern Bell curriculum and schedule at its Clemson school, and with the usual engineering curriculum in his mind, one professor observed, "It looks like Southern Bell's intent is to whet the appetite of its students." He was contrasting the very rapid coverage in the telephone course with the thorough subject exploration and exposition that is typical of college courses. Having in mind the practical aspects of time limitations and the expected high quality of students, the steering committee planned a course of study that covered a great deal of ground quickly. We hope that we are not wrong in expecting that this communications training will stir up in each man such great interest that he will turn to a deeper home study of many of the subjects he encountered at Clemson. Certainly, an engineer who wishes to grow and develop and succeed will feel strongly that he needs to exert off-the-job effort to further his own development. There is, of course, opportunity to sandwich into the day-by-day job the reading and study of technical material, but the man who is sincerely ambitious will realize that 8:30 to 5 efforts are not enough.

We expect that engineers who have had this training thereby will have been equipped to get for themselves the most out of the technical information normally available for their use. And when new problems arise, problems that have not been anticipated or problems concerning new and different communications' services, the transmission engineers will have the basic knowledge to solve these problems. This is vastly important in the day of decentralization of telephone engineering and of a host of new and different services wanted and offered.

Highly important is the fact that this program is bringing about a new and closer relationship between education and industry. Formerly, industry has been considered to be interested only in profit, and the college to be interested only in courses in theory. The Clemson venture shows that this need not be so, for participation in this joint activity has developed a mutual interest and a realization that both education and industry can benefit greatly from working together.

Appendix A

Outline of School Program

Course I. (3 weeks)

A. Acoustics
   1. Sound
   2. Acoustical engineering and noise
   3. Information theory
B. Transmission lines
   1. Network theory, passive networks
   2. Electric wave filters
   3. Transmission line theory
C. Active elements
   1. Vacuum tubes
   2. Transistors
   3. Gain devices

Course II. (2 weeks)

A. Noise-frequency induction
   1. Fundamentals, noise sources, components
   2. Influence, harmonics, measurements
   3. Coupling and shielding
   4. Susceptiveness, investigations, surveys
B. Selective devices
   1. Theory, shunts, capacitors
   2. Propagation of harmonics
C. Low-frequency induction
   1. Sources
   2. Symmetrical components
   3. Power system faults
   4. Coupling factors
   5. Shielding
D. Protection
   1. Lightning
   2. Telephone plant
   3. Protective measures
E. Corrosion
   1. Theory

Course III. (2 weeks)

A. Crosstalk
   1. Theory
   2. Types of crosstalk
   3. Toll cable crosstalk
   4. Number splicing
   5. Exchange cable crosstalk
   6. Open wire crosstalk
   7. Carrier system co-ordination
B. Carrier transmission
   1. History, why modulate
   2. Kinds of modulation
   3. Sampling principle
   4. Quantization, code transmission, multiplexing
   5. Amplitude modulation
   6. Frequency modulation
   7. Pulse modulation
   8. Oscillators
   9. Linear amplifiers
   10. Filters
   11. Compandors
   12. Noise
   13. Systems
   14. Co-ordination of systems
   15. A look into the future

Course IV. (2 weeks)

A. Radio
   1. Modulation
   2. Oscillators
   3. Amplifiers

Electrical Engineering Education

4. Discriminators
5. Limiters
6. Waveguides, coaxial transmission lines
7. Antennas
8. Wave propagation
9. Noise
10. Air/ground
11. Tropospheric or scatter

B. Theory of probability

Appendix B

Reference Material Used*

Textbooks

Active Networks, V. C. Rideout. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1954.

Applied Electronics, T. S. Gray. John Wiley & Sons, Inc., New York, N. Y., 2d ed., 1954.

Communication Engineering, W. L. Everitt, G. E. Anner. McGraw-Hill Book Company, Inc., New York, N. Y., 3d ed., 1956.

Electric Transmission Lines, H. H. Skilling. McGraw-Hill Book Company, Inc., 1951.

Electrical Communication, A. L. Albert. John Wiley & Sons, Inc., 3d ed., 1950.

Electrical Transmission & Distribution Reference Book, central station engineers of Westinghouse Electric Corporation. Westinghouse Electric Corporation, East Pittsburgh, Pa., 1950.

Electronic Engineering, Samuel Seely. McGraw-Hill Book Company, Inc., 1956.

Electron-tube Circuits, Samuel Seely. McGraw-Hill Book Company, Inc., 2d ed., 1958.

Acoustical Engineering, H. F. Olson. D. Van Nostrand Company, Inc., Princeton, N. J., 3d ed., 1957.

Elements of Pulse Circuits, F. J. M. Farley. John Wiley & Sons, Inc., 1955.

Frequency Analysis Modulation & Noise, Stanford Goldman. McGraw-Hill Book Company, Inc., 1st ed., 1948.

Modulation Theory, H. S. Black. D. Van Nostrand Company, Inc., 1953.

Pulse & Digital Circuits, Jacob Millman, H. Taub. McGraw-Hill Book Company, Inc., 1957.

Electronic & Radio Engineering, F. E. Terman and others. McGraw-Hill Book Company, Inc., 4th ed., 1955.

Symposium on Corrosion Fundamentals, edited by A. de S. Brasunas, E. E. Stansbury. University of Tennessee Press, Knoxville, Tenn., 1956.

Theory & Application of Microwaves, A. B. Bronwell, R. E. Beam. McGraw-Hill Book Company, Inc., 1947.

Transistor Electronics, A. W. Lo and others. Prentice-Hall, Inc., 1955.

University Physics, F. W. Sears, M. W. Zemansky. Addison-Wesley Publishing Co., Reading, Mass., 2d ed., 1956.

Vacuum Tube Circuits & Transistors, L. B. Arguimbau, with R. B. Adler. John Wiley & Sons, Inc., 1956.

Technical Articles

Theoretical Limitations on the Rate of Transmission of Information, W. G. Tuller. *Proceedings*, Institute of Radio Engineers, New York, N. Y., vol 37, no. 5, May 1949, p. 468.

*Not including Bell System material.

Television Receiver Designed for Classroom Use

A new type of television receiver especially designed for classroom use has been developed by Motorola. Called the "Classroom 21," the versatile new set can be used in either closed-circuit television systems or for viewing over-the-air broadcasts from educational and commercial stations.

When used in closed-circuit systems, the "Classroom 21" provide a high definition 500-line picture for detailed reproduction of laboratory experiments, microscopic slides, chalkboard illustrations, industrial and fine arts demonstrations, and maps and line drawings.

For receiving commercial broadcasts, the set is instantly changed from high definition closed-circuit operation to over-the-air pickup of broadcast television stations by operation of a simple switch.

Furthermore, installation of multiple classroom receivers is simplified by special r-f, video, and audio jacks. A front firing speaker assures clear reception, and a separate audio input jack allows use of the unit as a public address speaker for school announcements.

Tinted shatterproof safety glass provides a high contrast picture and reduces reflected glare. Motorola "Tube Sentry" circuitry triples tube life by controlling initial application of power to tubes, and a 20-foot heavy-duty service cord permits freedom of location.

The 19 by 28 by 17 inch set is supplied with a vinyl dust cover and is available in charcoal and blond grained finishes.

A classroom television stand that places the set at the proper height for student viewing and includes a tilt control to reduce overhead and window reflections is available as an accessory.

Cornell Students Receive Awards for Welded Designs

Five engineering undergraduates at Cornell University received all of the top awards this year in the annual mechanical and structural welded design competition sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. This is the first time in the 11 year history of the competition that students in one engineering school have made a clean sweep of the three top awards.

The Lincoln Foundation makes 46 awards each year recognizing the engineering ability of college undergraduates in the field of welded design. Awards are made for both mechanical and structural designs which make a significant use of arc welding for improvement and lower costs. The Lincoln Foundation also awards scholarship funds to the schools in which students were enrolled when making their designs.

Top award of $1,250 went to Richard Jarvis of Baltimore, Md., for his design of a triangular shaped foot bridge. John Jenner and E. R. McLean of LeRoy, N.Y., and Philadelphia, Pa., respectively, shared the $1,000 second award for the mechanical design of an automatic welding machine. Gordon Kraus and Robert Spicher designed a display arboretum which received the $500 third award. Honoring these awards, Cornell received $1,750 in scholarship funds to be administered by the mechanical and civil engineering departments.

The 1958-59 Rules Booklet for the current competition is now available from The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio. Undergraduates in all branches of engineering are eligible to participate.

New Textbook on Theory of A-C Circuits

Two Rutgers University professors have written a new textbook dealing with the analysis and synthesis of alternating current circuits

Authors of the new book, titled "Theory of A-C Circuits," are Sylvan Fich, professor of electrical engineering, and J. L. Potter, professor and chairman of the department of electrical engineering in the State University's College of Engineering.

The book interweaves the basic theory of a-c circuits with topics required for the study of modern network and communication theory. It is part of an integrated treatment to be continued by the authors in a proposed book on the theory of communication networks.

Dr. E. C. Easton, dean of the Rutgers College of Engineering, has announced that the book will be used this year as a text by electrical engineering students in the junior class.

Classroom tested, "Theory of A-C Circuits" is a modern, comprehensive work which introduces important mathematical material such as general phasor summations, trigonometric and hyperbolic functions of complex angles, advanced determinant relations, impulse function techniques in Fourier analysis and the Sampling Theorem along with a thorough exposition of basic theory and practical computation.

The book is published by Prentice-Hall Inc., Englewood Cliffs, N. J.

Nuclear Emulsion Scanner at University of Michigan

University of Michigan (U-M) physicists have combined a powerful microscope, a television camera, and a special electronic computer to form a machine that can recognize certain situations as well as humans can, and 15 times faster.

Their device is known officially as "a nuclear emulsion scanner." But they call it "Terry," for the Greek "Thereteira," or "huntress."

Terry's job is to detect and count the thousands of faint tracks left by atomic particles flying through thick sheets of special photographic film in U-M atom smasher experiments.

It represents "the first real success among half a dozen attempts in the United States and Europe to solve this

recognition problem instrumentally," says Terry's inventor, Prof. P. V. C. Hough.

Terry holds great promise of relieving humans of the slow, tedious task of examining hundreds of strips of film with microscopes, Professor Hough says.

The device can automatically scan as much film in 1½ hours as a human can in 4 days. Furthermore, it does so with 100% efficiency in all areas of the film, while a human observer's efficiency drops rapidly in areas of may tracks.

Terry's "eye" is the television camera. It looks through a 200-power microscope at a different tiny square of the film every 60th of a second.

Her "brain" is a specialized electronic computer which occupies 50 square feet of space. It "remembers" dots within the squares that are dark enough and wide enough to be parts of a track; if it detects 15 consecutive dots within a square, it records them as one track.

Terry's "hands" are an electronic printer which keeps a running count of the tracks, and a plotter which draws a graph showing the frequency of the tracks.

Another feature of the machine is definitely inhuman, Professor Hough says: the results of Terry's "consideration" of a scene can be displayed on a television screen at any state of her analysis. Her human bosses can then decide whether she is thinking correctly. "Psychoanalysts please copy," he notes.

"We have been handicapped by the fact that nobody really knows how humans recognize situations. We've had to select the vital features of each scene, then have trained Terry to remember only those features as she makes her survey."

The film strips come from the University's cyclotron, where they are used to record the flight of atomic particles deflected by the nuclei of the atoms in small targets, and sorted by a magnetic field.

The particles strike the film edge-on, leaving a faint line behind. By recording the number of particles flying through film placed at different angles from the target, the U-M physicists gather clues as to the structure of the nuclei of the target's atoms. Terry does this automatically.

As many as 30 of the film strips, representing more than 6 months of counting by a human, are used in just one experiment with the cyclotron, Professor Hough points out. The new scanner can process them in 4 to 5 days.

"The job of finding tracks with a microscope in a 12-inch strip of film is equivalent to locating a 1-inch-long needle with a 4-inch reading glass in a field of 20 feet wide and 240 feet long," he notes.

Terry does her work by looking for a millionth of a second at each of 130 squares which extend across the width of the film. After one band of squares is examined, the carriage holding the film shifts to the next band.

Professor Hough reports that he and his associates are trying to adapt Terry to the "much more complicated" recognition problems in the study of high-energy physics' "strange particles" and of cosmic radiation from outer space.

The product of 3 years' work, the creation and education of Terry has been supported by the Michigan-Memorial Phoenix Project, by the Atomic Energy Commission, and by the Physics Department. G. R. Garrison and F. M. Remley of the University Television Studio provided support and technical assistance.

Working with Professor Hough have been R. O. Winder, now at Princeton University; graduate students Wentworth Williams of Ann Arbor and Baden Cosby of Gravenhurst, Canada; technician J. A. Koenig of Whitmore Lake; and Marjorie Smit, a senior from Detroit.

ORINS Issues Directory of Research Opportunities

A "classified directory" of research opportunities available to college and university scientists, to be carried out in Oak Ridge Tenn., has been issued by the Oak Ridge Institute of Nuclear Studies (ORINS).

The "directory" is a brochure describing the Oak Ridge Research Participation program, now in its 10th year, that ORINS administers for the United States Atomic Energy Commission (AEC). The program is one that enables university scientists to carry out research in atomic-energy installations for periods of 3 months to a year. The new brochure describes the numerous opportunities for research involving the application of nuclear energy to basic sciences, agriculture, engineering, and medicine, utilizing facilities not generally available to any single university.

Primary site of research-participation appointments is Oak Ridge National Laboratory, leader in nuclear-reactor research and development, and the world's principal producer of radioisotopes. Other research appointments are available at the University of Tennessee–AEC Agricultural Research Laboratory, and at ORINS.

ORINS is a nonprofit, educational corporation of 37 southern universities and colleges. Copies of the research-participation brochure are available on request from the University Relations Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

Electrical Engineering Education

An Electrical Engineer in Industry

L. J. BERBERICH (AM '30, F '45), manager, engineering department, Associated Companies Division, Westinghouse International Company, East Pittsburgh, Pa.

"My progress as an engineer has been materially aided by the AIEE through attendance at meetings and the presentation of papers in my particular technical area. The professional contacts made at these meetings have turned out to be particularly valuable throughout my whole career. The publication of my first AIEE Transactions Paper in 1936 was a very stimulating experience and this led to a number of others. This privilege of publication plus the associations I made have enabled me to grow in stature in my profession and obtained for me recognition, not only nationally but internationally. Perhaps the most stimulating experience of my career involved the opportunity for being of service to the Institute and some of its members through serving as chairman of the Pittsburgh Section of AIEE as well as chairman of several technical committees and subcommittees."

Dr. Berberich received the degree of bachelor of engineering in electrical engineering in 1928 from Johns Hopkins University and then, after three years of graduate work, he was awarded the degree of doctor of engineering in electrical engineering and physics in 1931. As a practicing engineer, he started his career as a research assistant at Johns Hopkins and then spent several summers on the Westinghouse Student Course. His first position after leaving Johns Hopkins was in the Research and Development Laboratories of the Socony-Mobil Oil Company, Inc. After a number of years, he moved to the Westinghouse Research Laboratories as research engineer in the insulation department. Later he became manager of the Physical Section of the insulation department. In 1949, he transferred to the central engineering department of Westinghouse and became manager of liaison engineering. He was recently named to the position of manager, engineering department, Associated Companies Division, Westinghouse International Company, East Pittsburgh, Pa.

Dr. Berberich's activities in the AIEE have included chairmanship of the Pittsburgh Section in 1955, and service on the following Institute Committees: Research (1937-40), Basic Sciences (1951-57, chairman 1954-55); Rotating Machinery (1951-53); Dielectrics (chairman 1955-59;) and Science and Electronics Division (1954-59).

Electrical Engineering Education

ECPD Bibliography of Electrical Engineering Subjects

Engineers' Council for Professional Development (ECPD) has announced that Section VII—Electrical Engineering of a Selected Bibliography of Engineering Subjects is now available.

The Bibliography, which was originally printed in 1937 in five sections, is primarily intended for those who wish to continue study in engineering and allied fields and perhaps start building their own private libraries. Revision of Section VII—Electrical Engineering was accomplished under the direction of the ECPD Training Committee.

Divided into four parts—circuits and network analysis, electromagnetic fields, electrical equipment and devices, and systems and measurements, the electrical engineering section of the bibliography contains 119 titles.

It is available at 25¢ a copy from ECPD, 29 W. 39th St., New York 18, N. Y.

Admiral Rickover Receives Pupin Medal from Columbia

Rear Admiral H. G. Rickover, pioneer of the world's first nuclear powered engines, was awarded the first Michael I. Pupin 100th Anniversary Medal on October 23 at a Columbia University Club forum luncheon at which he was the featured speaker.

The Pupin Medal, established by the Columbia Engineering School Alumni Association for "service to the nation," was presented by L. H. F. Mouquin, president of the association.

It was awarded to Admiral Rickover, a Columbia alumnus, for his history-making achievement in putting atomic energy to practical nonexplosive use and specifically for his key role in the development of the atomic-powered submarines *USS Nautilus*, *Triton*, and others.

Admiral Rickover, U. S. Naval Academy graduate in 1922, received his master of science degree in electrical engineering from the Columbia School of Engineering in 1929 when Professor Pupin was still teaching.

The Pupin medalist was introduced at the luncheon by Dr. J. R. Dunning, dean of the Engineering School, who is himself famed as one of the nation's first atomic scientists. The ceremonies, held at the Columbia University Club, were jointly sponsored by the Military–Naval Club.

The medal presented to Admiral Rickover was the first to be bestowed by the Engineering Alumni Association during the Pupin anniversary year. This began October 4 and runs to the Fall of 1959, and commemorates the birth 100 years ago of Michael Idvorsky Pupin (1858-1935), American physicist and inventor, who was professor of electromechanics at the Columbia Engineering School from 1901 to 1931.

Yugoslav-born Dr. Pupin is known for his pioneering inventions in communications and for his researches in Xray. The Pupin Physics Laboratories building at Columbia is named for him.

Admiral Rickover is both chief of the Naval Reactor Branch of the Atomic Energy Commission and assistant chief of the Navy's Bureau of Nuclear Propulsion.

In 1955, he received the Egleston Medal, awarded annually by the Alumni Association to a graduate of the Columbia Engineering School for outstanding services in the field of engineering.

The forum luncheon on October 23 marked the first of a series of public interest programs planned by the Columbia University Club during the year.

Undergraduates To Compete on Television Quiz Program

"College Quiz Bowl," a new series of Sunday afternoon programs will make its debut over the CBS Television Network, January 4, 1959, under the sponsorship of General Electric Company, Housewares and Radio Receiver Division, it was announced by M. M. Masterpool, advertising manager of the Division.

The program, a new idea in television panel quiz formats, will have undergraduates of colleges and universities competing for cash prizes which will go to the Scholarship Funds of their respective schools. Live originations are planned from the various colleges represented on the series.

"College Quiz Bowl," emceed by Allan Ludden, will be presented Sundays at 5:00-5:30 p.m. EST. The program is a Moses, Reid, Cleary production.

Tau Beta Pi Holds National Convention in Boston

Tau Beta Pi's 53rd national Convention was held in Boston, Mass., on October 9-11, 1958. The five Massachusetts chapters, at Worcester Polytechnic Institute, Massachusetts Institute of Technology (MIT), Tufts University, Northeastern University, and the University of Massachusetts, were official hosts. All of the national engineering honor society's 100 active collegiate chapters were represented at the session. The Convention was also attended by Tau Beta Pi's national officers headed by Pres. H. M. King, retired General Electric Company turbine engineer, of Swampscott, Mass. and Pres.-elect D. A. Dahlstrom, director of research and development for the Eimco Corporation, Palatine, Ill.

The Convention, headquartered at the Hotel Vendome in Boston, consisted of four business meetings, three held in the hotel and one at MIT, several specially arranged discussion periods, and a banquet program of particular interest. Plans for the national meeting were made under the general direction of W. E. Overstreet, arrangements chairman and MIT graduate student, who had the assistance of the members, officers, and advisors of all five of the Massachusetts chapter. P. H. Robbins, executive director of the National Society of Professional Engineers Washington, D. C., and Tau Beta Pi's director of fellowships, served as chairman of the Convention business meetings.

The main speaker on the welcoming luncheon program on Thursday, October 9, was Dr. W. C. White, vice-president and provost of Northeastern University, a very prominent engineering educator, and a former member of Tau Beta Pi's Fellowship Board.

The Convention granted new chapters of Tau Beta Pi to local engineering honor societies at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, and the University of Vermont, Burlington, which had submitted petitions for charters last winter. The new chapters, to be designated Ohio Eta and Vermont Alpha, will be installed this winter as Tau Beta Pi's 101st and 102nd active undergraduate chapters.

The Convention voted to hold the 1959 national meeting in October at Purdue University with the Indiana Alpha chapter there as official host.

A major event of the Convention in Boston was the initiation and banquet on Friday evening, October 10. The initiation ceremony was conducted by members of the Executive Council and officers of Tau Beta Pi for 23 students of Northeastern University and MIT and for four prominent professional men, Professors E. R. Gilliland and M. J. Holley of MIT; E. D. Sabin of Wait Associates, New York, N. Y.; and Brig. Gen. A. K. Sibley, U. S. Army Corps of Engineers. Gen. Sibley, New England district engineer and former Rhodes scholar, delivered the major address on the after-dinner program.

Another feature of the initiation banquet program was the announcement and presentation by President King of the winners of the Outstanding Chaper Awards for 1957-58. Top prize in this competition went to the Missouri Beta chapter at the Missouri School of Mines, and honorable mentions were given to California Gamma at Stanford University, Maryland Alpha at Johns Hopkins University, and Texas Alpha at the University of Texas. Pres.-elect Dahlstrom also presented special appreciation plaques to the five members of the retiring Boston Executive Council of Tau Beta Pi and cited their many contributions during their 4-year term of office.

Valuable features of Tau Beta Pi Conventions are the chapter-work discussions and the exhibits at which ideas for school and community service projects and chapter administration are exchanged by the delegates, most of whom are presidents of their local groups. This year's discussions in that field were again led by students under the general direction of Dr. M. E. Van Valkenburg of the University of Illinois, chapter co-ordinator for Tau Beta Pi.

Tau Beta Pi is a national engineering

honor society which was founded at Lehigh University, Bethlehem, Pa., in 1885. It now has 100 active undergraduate chapters in United States engineering colleges, 26 alumnus chapters, and over 97,000 initiated members. Students are elected to membership by the chapters from the top 20% (scholastically) of their engineering classes on the basis of character and service to their colleges. Alumni may be elected on the basis of their eminent achievements in the engineering profession.

Tau Beta Pi's Executive Council, or board of directors, in office at the time of the Convention, included five alumnus members who live in or near Boston. In addition to Pres. King, the Council included Vice-Pres. W. C. Voss, consulting engineer and retired head of the building engineering and construction department at MIT; Dr. L. W. Bass, vice-president of A. D. Little, Inc., Dr. C. F. Muckenhoupt, chief scientist of the First Naval District; and Dr. H. K. Brown, research mathematician with the Avco Corporation.

The incoming Executive Council, is located in or near Chicago, Ill. It is headed by Dr. Dahlstrom and includes Vice-Pres.-elect A. W. Consoer, of Consoer, Townsend & Associates; and Councillors-elect Dr. G. G. Lamb of Northwestern University; Dean R. G. Owens of Illinois Institute of Technology; and L. C. Rogers of Bates & Rogers Construction Company.

University of Illinois Quality Control Short Course

The 12th annual short course in Quality Control by Statistical Methods will be offered by the College of Engineering, University of Illinois, with the co-operation of the Division of Engineering Extension at Urbana from January 26 through February 5, 1959. Intensive work will be given in the fields of control charts and acceptance sampling with some attention paid to the rational setting of specifications and tolerances. It is designed for those in the areas of design, production, procurement, management, quality control, and inspection.

For further information, write to: Prof. J. A. Henry, Room 205, Mechanical Engineering Laboratory, University of Illinois, Urbana, Ill.

Co-chairmen Named for Columbia Engineering Fund

Dr. J. F. Thompson, chairman of the board of International Nickel Company, Inc., and J. N. Murray (AM '12, M '18, Member for Life), retired consulting electrical engineer, have been named co-chairmen of the Annual Columbia University Engineering Fund for 1958. They head the current drive to raise unrestricted funds for the Columbia School of Engineering.

Dr. Thompson is a graduate of Columbia University School of Mines, where he received his Ph.D. degree in 1906. A current leader in the nonferrous metals industry, he has been with International Nickel for 50 years and is a director of many corporations and a member of a number of engineering societies, including the American Society for Metals and the American Institute of Mining, Metallurgical, and Petroleum Engineers. He holds an honorary degree of doctor of science from Columbia and doctor of laws from Queen's University, Canada.

Mr. Murray, a native New Yorker, graduated from the Columbia School of Mines in 1911 and is retired as a consultant in the hydroelectric field. He was president of his class at Columbia and holds the Alumni Medal of the University.

U M Reports on Demand For Engineering Graduates

Over-all demand for engineering graduates probably will be somewhat higher in 1959, a University of Michigan (U-M) official indicates.

In the annual report for 1957-58, Assistant Prof. J. G. Young, head of the Placement Office for the College of Engineering, states that increased defense requirements will serve to create more jobs and that commercial optimism also will help.

The report points out that demand probably will be especially strong for electronics engineers and scientists, but also will be relatively high for all engineering branches.

The 1957-58 period was notable for the first substantial reversal in the upward trend of engineering demand which started in 1950. It began as a result of defense contract cancellations and adjustments during the Summer of 1957 and was furthered by the developing business recession during the rest of the year.

Additional reductions resulted from completion of plant expansion projects and from changes in military service policy which released many engineering graduates to industry earlier than had been expected.

The over-all effect was to reduce the national demand for engineers about one third over the previous year. In spite of this, the report states, virtually all U-M graduates were able to find satisfactory employment before graduation.

The drop in campus recruiting was relatively much less than the over-all decline in demand for graduates.

This seemed to stem from the two main principles: (1) continuing competition for top-level graduates, and (2) general acceptance of the belief that the long-run need for engineers will continue to exceed the probable supply. This means that recruiting has to be continued to maintain a good position for meeting future needs.

The total number of offers reported to the Placement Office for regular employment was 532 compared to 816 for the previous period. Salary average at the bachelor of science level was $480 per month, up $15; at the master's level, $570, up $18; and at the doctorate level, $732, up $52.

Electrical Engineering Education

These increases, however, were lower than the approximate 10% increases for each of the two earlier years.

In ranking of industries by average salaries offered, electrical product manufacturing rose from fourth to first place, but there was little change in the standing of other industries or in the ranking of the various fields of engineering.

For the 1957-58 year covered, there were 826 engineering graduates, up 52 or about 7% from the previous year. Some 1,414 students from all of the University's schools and colleges participated in interviews with prospective employers, with 1,207 of these students coming from the Engineering College.

From the employers' viewpoint, 494 separate representatives arranged for interviews, down from 550 the previous year. These resulted in 728 actual visits to the University for both fall and spring semesters. While the visits dropped from the 792 of the year before, there were 111 cancellations because of lack of openings. The true reduction in visits, therefore, was 175, or 22%. There had been virtually no cancellations for lack of openings the previous year.

Graduate Study Program in E.E. Offered by Marquette

A graduate study program leading to a master of science degree in electrical engineering became effective September 1, 1958, at Marquette University. Dr. J. D. Horgan, chairman of the electrical engineering department, stated that in pursuing the degree, the graduate student may place the emphasis of his study in the area of automatic control, circuit theory, electronics, field theory, electrical machinery, or computer technology. The primary purposes of the graduate program in electrical engineering are:

1. To obtain a deep insight and a mature understanding of the basic science fundamentals.

2. To develop an awareness of the analytical and experimental methods, which are applicable to engineering problems.

3. To apply these fundamentals and methods to the solution of engineering problems.

4. To gain an understanding and appreciation of the procedures of research.

5. To acquaint the student with current and classical scientific literature and its application.

Students who wish to be admitted to a program leading to the degree of master of science in electrical engineering, must hold a bachelor's degree in electrical engineering from an accredited institution, or the equivalent of this degree. Because of

Electrical Engineering Education

the importance of research in this field, all participants in the electrical engineering program will be requested to submit an acceptable thesis.

The degree will require 24 semester hours of credit and 6 hours of directed research, culminating in a thesis report.

Attractive teaching opportunities and fellowships are available for quailified applicants.

Information on the program, and financial aid is available from the Chairman of the Electrical Engineering Department, Marquette University, Milwaukee 3, Wis.

Union College Professor Named to ASEE General Council

R. B. Russ (M '47), professor of electrical engineering at Union College, Schenectady, N.Y., has just been elected to a 2-year term on the General Council of the American Society for Engineering Education (ASEE). His election took place in Toronto, Ont., Canada, November 1, during the annual meeting of ASEE's upper New York State–Ontario Section.

Comprised of representatives from all of the ASEE's various sections, the General Council is the top legislative and policy-making body. Part of its function is to examine and make recommendations concerning problems common to engineering schools throughout the nation.

Prof. Russ, who has been a member of ASEE for 10 years, has been associated with the faculty at Union College on two different occasions, initially during 1941-42 and continuously since 1948. During the interim years, he was employed by the General Electric Company, serving for a time as chief engineer of the company's Easthampton Tube Works and later as section engineer in charge of advanced developments for the Electronics Tube Division.

A native of Hartford, Conn., Prof. Russ is an alumnus of Yale University.

Hydroelectric Dam and Generator Kit for Schools

A series of new products on the subject of electricity has been announced by Product Design Company, Redwood City, Calif., designers of science teaching aids for elementary and junior high schools. The focal point of the new series is a model Hydroelectric Dam and Generator Kit. The dam reservoir is molded from sturdy polystyrene, and materials are provided for pupils to construct their own dam. Extensive use of clear plastic in the generator unit permits full observation of all working parts. An intake tower controls the flow of water through the penstock to operate the turbine generator. The generator unit will also work independently off any faucet outlet. Six volts a-c current are generated—sufficient to light a lamp, ring a bell, or operate a small d-c motor. Accessories include a rectifier and d-c motor, transmission lines and transformer, ammeter, voltmeter, a hydraulic kit, and a kit for teaching magnetism.

As with all Product Design Kits, a detailed manual, prepared and edited by science teachers, is provided. The 50-page manual describes, in easily understood terms, the function of hydroelectric dams, the generation of electric power, and the physical properties and principles of electricity. Numerous experiments for various age groups are included and a suggested program outlines the organization of student participation.

Experience with these and other Product Design Kits (Model Water Treatment Plant, Conservation Kit, and Pump Kits) has demonstrated conclusively the effectiveness of working models as science teaching aids. Science principles are related to familiar, observed phenomena. The result is a high level of student interest and participation, more effective learning, and a powerful stimulus to youthful creativeness.

Faculty Promotions at California Institute of Technology

Promotion of 15 faculty members of the California Institute of Technology by action of the Board of Trustees was announced recently by President L. A. DuBridge.

The promotions, are as follows: J. G. Bolton, for the past three years senior research fellow in physics and astronomy, was appointed professor of physics and astronomy. He is also scientific director of Caltech's radio observatory in the Owens valley.

From assistant professor to associate professor: A. V. Tollestrup and Ward Whaling, physics; N. H. Brooks, civil engineering; T. K. Caughey applied mechanics; R. W. Gould, H. C. Martel, and R. D. Middlebrook, electrical engineering; Anatol Roshko, aeronautics; and A. J. Acosta and Thad Vreeland, Jr., mechanical engineering.

From instructor to assistant professor: F. C. Anson, analytical chemistry and Winston Royce, aeronautics. From research fellow to assistant professor: Matthew Meselson, physical chemistry, and G. N. Richter, chemical engineering.

From research fellow to senior research fellow: Yuen Chu Leung, chemistry.

Prof. Bolton, although still in his mid-thirties, is regarded as one of the pioneers in the discovery of radio noise sources. He went to Caltech from Australia in 1955 to help design the observatory of the radio astronomy project, to supervise its construction, and to serve as its scientific director. A graduate of Cambridge University, Prof. Bolton joined the Commonwealth Scientific and Industrial Research Organization upon completion of his service with the Royal Navy, and later became the youngest man ever appointed to the rank of principal research officer in that organization.

Use of Testing Reactor Offered to Universities

Westinghouse Electric Corporation has announced plans to invite colleges and universities to use irradiation space in its new testing reactor without charge in order to further basic research and education in nuclear fields.

The announcement represented private industry's first offer to give nuclear educators and those conducting university research programs the opportunity to gain additional knowledge through the use of an operating test reactor.

E. T. Morris, manager of the Westinghouse Testing Reactor (WTR), said that the space will be available free of charge to any research or study program that is supported and wholly financed by a college or university. A total of 3,000 cubic inches of irradiation space in the reactor will be reserved for this purpose. Mr. Morris said there would be a nominal charge to cover the costs of handling of insertions and retractions, health physics examinations of the material, and preparation for its shipment. "We will also offer co-operative summer programs for nuclear study and research to instructors and professors of physics and the nuclear sciences," he added.

"WTR is being built to serve as a research and development tool to help solve the many fuel and material problems which must be solved if economic nuclear power is to become a reality," Mr. Morris explained. "It will be capable of providing appropriate environments for testing power reactor fuels, materials and coolants and post-irradiation examination and evaluation of these tests."

The WTR facility will go into operation next spring and will be ready for use by educational institutions during the summer of 1959.

Engineering Students at UW Receive Scholarships

Some 25 students who have been awarded scholarships by American industry and engineering education foundations to help them continue their engineering education at the University of Wisconsin (UW) during the 1958-59 school year have been named by UW College of Engineering officials.

Of the scholarships, 12 are given to the University by the Foundry Educational Foundation, 4 by Ladish Co., 2 by Pelton Steel Casting Co., 2 by International Nickel Co., 2 by American Smelting and Refining Co., and one each by American Society for Metals, Institute of Scrap Iron and Steel, and Kennecott Copper Co.

The scholarships are awarded by the UW College of Engineering faculty on the basis of the students' scholarship and

need, and their interest in the mining and metallurgical, mechanical, and electrical engineering industries, Prof. P. C. Rosenthal, chairman of the mining and metallurgy department, said. Scholarships range from $250 to $1,000.

"These scholarships are of invaluable aid to our students, many of whom are in need of some financial help during their University careers," Prof. Rosenthal said. "At the same time, these scholarships reward those students who do promising work in their studies and training for engineering jobs in American industry, which needs well-trained engineers now more than ever in our history."

Scholarships and their recipients for the current school year are:

Foundry Educational Foundation ($365 to $450)—T. J. Bosworth, W. F. Shaw, L. E. Abrahamson, J. E. Hansen, and P. H. Meyst, all of Madison; J. E. Cantwell, Delavan; A. H. Meyers, Milwaukee; A. C. Mueller, Waukesha; J. R. Widmeyer, LaCrosse; D. H. Eber, Racine; G. H. Kerckhove, Bloomer; and J. P. Tralmer, Chicago.

Pelton Steel Casting Co. ($500 to $600)—E. M. Pilerski, West Allis; and James Waldenberger, Onalaska.

Ladish Co. ($300)—K. R. Olen, Cudahy; Orville Moody, Jr., Belmont; T. A. Pitterle, Milwaukee; and T. A. Roth, DePere.

American Society for Metals ($500)—R. J. Stueber, Juneau.

International Nickel Co. ($500)—D. R. Nelson, LaCrosse; and J. M. Svobeda, Milwaukee.

American Smelting and Refining Co. ($500)—H. J. Brown, Oshkosh; and T. W. Mueller, Wausau.

Institute of Scrap Iron & Steel ($250)—R. R. Matarrese, Kenosha.

Kennecott Copper Co. ($1,000)—J. W. Nichlos, Reedsburg.

New Faculty Members at Colorado School of Mines

Ten new faculty members were appointed to the staff and faculty at the Colorado School of Mines, Golden, Colo., for the fall semester, it was announced by Dr. J. W. Vanderwilt president of the mineral engineering college. The addition of the dozen new members (two were announced previously) brings the full-time teaching faculty at Mines to 110. Mines, with an enrollment of 1,100, has a student—faculty ratio of ten to one.

Three of the new faculty members were appointed to the metallurgical engineering staff which this year moves into a new, $1 million classroom and laboratory building. Dr. M. T. Hepworth, who holds an undergraduate degree from the Massachusetts Institute of Technology (MIT) and doctorate from Purdue University, was named an assistant professor. He formerly was a minerals research engineer for General Motors and Union Carbide and Carbon Corporations. W. J. Guay, formerly a research engineer with the Anaconda Co., is a new metallurgy instructor. He holds his masters degree from the Montana School of Mines. Mrs. Frances Fry, who holds a bachelors degree from Waynesburg College, is a new research technician in metallurgy.

Dr. L. W. Morgan, who has an undergraduate degree from MIT and his Ph.D. from the Georgia Institute of Technology, was named an associate professor in petroleum-refining. Previously he has been a systems engineer for the Phillips Petroleum Co., and a research engineer at Georgia Tech.

Dr. Leonid Bryner, formerly a geologist with the U.S. Geological Survey team and geologist for the Bear Creek Mining Co., was named an assistant professor of geology. He holds his doctorate from the University of Arizona.

Lt. Col. B. D. Jones, formerly a Corps of Engineers battalion commander at Ft. Lewis, Wash., is the new professor of military science and tactics. He has a bachelors degree from Oregon State College and a masters degree in mining engineering from Colorado Mines.

A. L. Gosman, formerly on the mechanical engineering teaching staff at Mines and more recently a senior development engineer for the Northrop Aircraft Corp., returns to Mines as an assistant professor of mechanical engineering. He holds a bachelors degree from the University of Michigan.

Ulf Berg has been named a mining engineering laboratory research assistant. Previously an explosives engineer for the Du Pont Explosives Laboratory and an explosives research physicist at Sweden's National Defense Research Institute, he holds a masters degree in physics from the University of Stockholm, Sweden.

Two administrative officers were also named. P. P. McGraw, formerly director of business services for Colorado's Jefferson County R-1 school district, is the new Mines budget officer. He is a graduate of the University of Denver. B. R. Pugh, a graduate of Colorado State University (CSU), is the new director of student activities, coming to Mines from a similar post at CSU.

Previously named as new faculty members were: Dr. J. S. Rinehart, former associate director of the Smithsonian Astrophysical Observatory and director of the U. S. Satellite Visual Tracking program, as full professor of mining engineering and director of the mining engineering research laboratories, and Byron Darnell, formerly instrumental supervisor and string consultant for the Denver Public Schools, as music director.

Electrical Engineering Education

TV Program Promotes Engineering Careers

ENGINEERING CAREERS in the Milwaukee area are receiving a big boost through the joint cooperation of television, industry, and education in a 13-week public service television series presented over Station WISN-TV. The program, engineering "Challenge," is produced in cooperation with the Milwaukee School of Engineering and Milwaukee area firms. Here, Controls Company of America shows the outstanding career opportunities for young men in the mushrooming control field. Shown *(left to right)* are Phil Starbuck, vice-president and director of industrial relations at Controls Company; Lee Murry of WISN-TV, and program participants E. E. Burmeister, Harry Weigert, and Robert Bauer, all of Controls Company.

INSTITUTE ACTIVITIES

Largest Technical Program Scheduled for 1959 AIEE Winter General Meeting

THE AIEE Winter General Meeting, to be held at the Hotel Statler (meeting headquarters), the Hotel Sheraton–McAlpin, and the Hotel Governor Clinton, New York, N. Y., February 1-6, 1959, will feature the largest technical program in the history of the Institute. The social activities, for which the Winter General Meeting is well known, will again be outstanding. A group of varied and interesting inspection trips has been arranged, closely allied with the technical sessions.

General Session

The featured speaker at the general session on Monday afternoon, February 2, 1959, will be James R. Killian, Jr., chairman of the MIT Corporation and also Special Advisor to the (U.S.) President on Science and Technology. During this session, the AIEE Medal in Electrical Engineering Education will be presented to Dr. J. F. Calvert, head of the electrical engineering department, University of Pittsburgh. The AIEE prize paper awards will also be presented at this time. President L. F. Hickernell will open the session with his report to the members of the Institute.

Special Session

At a special session at 1:45 p.m. Wednesday, February 4, the John Fritz Medal will be awarded to Dr. M. J. Kelly, president of the Bell Telephone Laboratories, Inc.

Edison Medal

Dr. C. F. Kettering, who died on November 25, 1958, had been chosen to receive the Edison Medal. The citation reads, "For invention, research, and development in the broad fields of industry, engineering, transportation, medicine, education, energy, and power resulting in service to all mankind." The medal will be presented posthumously.

Technical Sessions

The highlight of this meeting will be the technical program, notable for a variety of subject matter as well as timely and interesting papers. A tentative schedule of technical sessions follows. (Titles of papers will be published at a later date.)

Monday, February 2

9:00 a.m. Morning Sessions

Transmission and Distribution
Transformers
Rotating Machinery
Computing Devices
Electronics
Basic Sciences
Electric Heating
Management
Cathodic Protection
Electronics
Television and Aural Broadcasting
Data Communications
Radio Communications
Nucleonics
Electronics
Substations

2:00 p.m. General Session

Tuesday, February 3

9:00 a.m. Morning Sessions

Transmission and Distribution
Transformers
Rotating Machinery
Computing Devices
Electrical Insulation
Electronics
Basic Sciences
Industrial and Commercial Power Systems
Aircraft and Flight Test Instrumentation
Section Representatives Conference
Professional Conduct and Registration of Engineers
Data Communications
Radio Communications
Chemical Industry
Electronics
Nucleonics
Television and Aural Broadcasting

2:00 p.m. Afternoon Sessions

Transmission and Distribution
Transformers
Rotating Machinery
Computing Devices
Electrical Insulation
Electronics
Basic Sciences
Industrial and Commercial Power Systems
Recording and Controlling Instrumentation
Section Representatives Conference
Chemical Industry
Electronics
Nucleonics
Television and Aural Broadcasting Systems
Radio Communications Systems
Education
Rotating Machinery

Wednesday, February 4

9:00 a.m. Morning Sessions

Transmission and Distribution
Power System Communications
Rotating Machinery
Computing Devices
Electrical Insulation
Electronics
Production and Application of Light
Feedback Control Systems
Industrial Power Rectifiers
Indicating and Integrating Instruments
Research
Transformers
Switchgear
Semiconductor Switching Devices
Telegraph Systems
Wire Communications Systems
Rotating Machinery

2:00 p.m. Afternoon Sessions

Transmission and Distribution
System Engineering
Switchgear
Rotating Machinery
Computing Devices
Electrical Insulation
Electronics
Feedback Control Systems
Electric Welding
Industrial Power Rectifiers
Transformers
Metal Industry
Semiconductor Switching Devices
Communication Theory
Telegraph Systems
Wire Communication Systems
Indicating and Integrating Instruments
Rotating Machinery

Thursday, February 5

9:00 a.m. Morning Sessions

System Engineering
Switchgear
Relays
Computing Devices
Electrical Insulation
Electrical Techniques in Medicine and Biology
Communication Theory
Domestic and Commercial Applications
Feedback Control Systems
Special Instruments and Auxiliary Apparatus
Safety
Substations
Semiconductor–Metallic Rectifiers and Magnetic Amplifiers
Transformers
Transmission and Distribution
Metal Industry
Land Transportation

2:00 p.m. Afternoon Sessions

Insulated Conductors
System Engineering
Switchgear
Computing Devices
Electrical Insulation
Magnetic Amplifiers
Solid-State Devices
Communication Theory
Metal Industry
Special Instruments and Auxiliary Apparatus
Safety
Substations
Land Transportation
Relays
Feedback Control Systems
Electrical Techniques in Medicine and Biology
Communication Switching Systems

Friday, February 6

9:00 a.m. Morning Sessions

Rotating Machinery
Insulated Conductors
Power Generation
Substations
Computing Devices
Magnetic Amplifiers
Solid-State Devices
Land Transportation
Industrial Control
Special Instruments and Auxiliary Apparatus
Chemical Processes and Petroleum Industries
Mining Industry
System Engineering
Electronics
Communication Switching Systems
Feedback Control Systems
Electronics
Electronics

2:00 p.m. Afternoon Sessions

Insulated Conductors
Power Generation

Protective Devices
Computing Devices
Magnetic Amplifiers
Solid-State Devices
Land Transportation
Industrial Control
Substations
Chemical Processes and Petroleum Industries
Mining Industry
Special Instruments and Auxiliary Apparatus
Electronics
Communication Switching Systems
Feedback Control Systems
Electronics
Electronics

The Road to Scientific Supremacy?

Among the many technical sessions of the meeting, "The Road to Scientific Supremacy?" sponsored jointly by the Research and Management Committees, will be of outstanding interest and importance. The policies and implementation of major governmental research will be outlined by prominent speakers. The role of Government research laboratories will be told by Dr. A. V. Astin, director of the National Bureau of Standards. Rear Adm. Rawson Bennett, chief of Naval Research, will discuss the U. S. Navy and research progress. The story of the outlook on science in Canada and England will be given by B. G. Ballard, vice-president (scientific), National Research Council of Canada, and the role of the National Academy of Sciences-National Research Council will be explained by Dr. D. W. Bronk, president, National Academy of Sciences, and president of the Rockefeller Institute for Medical Research.

Informal Tea

This social gathering before the formal program begins has been enjoyed by more and more people each year. Make it a point to attend this year—Sunday afternoon, February 1, from 4 to 6 p.m., in the Penn Top of the Statler. There will be no charge.

During this period, the registration facilities will be open for those who wish to avoid the Monday morning rush.

Hotel Reservations

With the cancellation of the Fall General Meeting in Pittsburgh, Pa., a good portion of the program intended for that meeting has been added to that of the Winter General Meeting and, therefore, it is anticipated that the attendance at this meeting will be considerably increased. Therefore, it is particularly important that your hotel reservations be made early.

Blocks of rooms have been set aside at the Statler and nearby hotels for members and guests attending the meeting. Requests for reservations should be sent to the hotel of your choice, specifically referring to the AIEE meeting in your letter. Please do not write to more than one hotel. If your request cannot be filled, the hotel will automatically refer your request to the Hotel Accommodations Committee whose duty it is to obtain a similar reservation at another of the convention hotels. The hotel will confirm directly to you. No guarantee that you will be housed satisfactorily can be made if your request is received after January 12, 1959.

Because of the crowded conditions in New York hotels, it is suggested that reservations be made for arrival on Sunday, February 1, 1959, thereby avoiding delays in registration or unavailability of rooms in the early morning of subsequent days.

Rooms have been allotted for our use by the following hotels at the daily rates indicated below:

Hotel Statler (meeting headquarters), 7th Ave. 32nd St. to 33rd St.	
Single Room	$ 8.00 to $14.00
Double Room	11.00 to 18.00
Twin Bedroom	15.00 to 22.00
Hotel Sheraton-McAlpin (also used for meetings), Broadway and 34th St.	
Single Room	$ 8.00 to $12.50
Double Room	11.00 to 15.50
Twin Bedroom	12.00 to 15.50
Hotel New Yorker, 8th Ave. at 34th St.	
Single Room	$ 8.00 to $14.50
Double Room	11.50 to 18.00
Twin Bedroom	15.00 to 20.00
Hotel Martinique, Broadway and 32nd St.	
Single Room	$ 6.50 to $11.00
Double Room	9.50 to 14.50
Twin Bedroom	9.50 to 14.50
Hotel Governor Clinton, Seventh Ave. at 31st St.	
Single Room	$ 7.50 to $12.00
Double Room	11.00 to 14.00
Twin Bedroom	12.00 to 17.00
Hotel Commodore, Lexington Ave. and 42nd St	
Single Room	$ 7.00 to $17.00
Double Room	13.00 to 19.00
Twin Bedroom	12.00 to 17.00
Hotel Roosevelt, Madison Ave. and 45th St.	
Single Room	$ 8.50 to $19.50
Double Room	13.50 to 23.50
Twin Bedroom	17.50 to 24.50

All rooms have private bath and the rates quoted are subject to a 5% New York City hotel room tax.

Smoker

A highlight of the Winter General Meeting will be the Smoker to be held Tuesday evening, February 3, 1959. Good food, good fellowship, and top quality entertainment will be the feature of this event which will take place in the Hotel Statler.

Attendance will be limited for the comfort of the guests. Ticket requests should be mailed at an early date. The price will be $11 per ticket and requests should be addressed to "AIEE Smoker Committee," 33 W. 39th St., New York 18, N.Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Dinner-Dance

Dinner-Dance will be held Thursday evening, February 5, in the Hotel Statler. Dress will be formal. Write soon for reservations for tables for 10. The price this year is $12.50 per ticket and requests should be sent to "AIEE Dinner-Dance Committee" at 33 W. 39th St., New York 18, N.Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

Inspection Trips

A program of inspection trips of both technical and general interest has been arranged for those attending the Winter General Meeting. Because the number of persons who may be accommodated on each of these trips is limited, members who are interested are urged to make arrangements and obtain full details at the Inspection Trips Desk immediately after registering.

Abilities Incorporated, Albertson, N.Y. (Wednesday afternoon). Abilities Incorporated is a unique industry which employs only disabled people, normally lost to industry. Employees include cardiac heart

DURING THE AIEE WINTER GENERAL MEETING, an inspection trip will be made to Abilities Incorporated, Albertson, N.Y., a unique industry which employs only disabled people normally lost to industry. The guided tour through the facilities will show these employees producing, competitively with other industries, such equipment as electronic printed circuits, coils, harnesses, and small mechanical assemblies.

cases through the range to quadruple amputees. The guided tour through the facilities will show these employees producing, competitively with other industries, such equipment as electronic printed circuits, coils, harnesses, and small mechanical assemblies. Equipment has been improvised to permit most of the plant operations in a sedentary position. Abilities is a pioneer facility demonstrating to industry that the disabled can work competitively with others.

Bell Telephone Laboratories, Murray Hill, N.J. (Tuesday afternoon). The group will assemble in the Arnold Auditorium at 2 p.m. There will be a talk by A. R. Brooks, publication manager, New Jersey Operations, to describe the Laboratories, their place in the Bell System and their method of operation in development and research fields. Following this, there will be a lecture on solid-state devices and their operation.

Groups will visit a cross-section of different laboratories, presenting a broad picture of the scope of scientific fields covered.

Bus leaves Statler 12:45 p.m., returns 5:15 p.m. Reservation $2.

Brookhaven National Laboratory, Upton, N.Y. (all day Thursday). The facilities at this location are operated by Associated Universities, Inc., under contract with the Atomic Energy Commission, and constitute the northeastern center for nuclear research and development in the fields of physics, chemistry, biology, medicine, and engineering. Important exhibits which members will see are the atomic pile, hot laboratory, and cosmotron. A complete tour has been arranged and competent guides, engineers, and scientists will be on hand to explain fully the extensive facilities and exhibits which have been erected at this vast site.

Bus leaves Statler 8:00 a.m., returns 5:30 p.m. Reservation $5.25, includes bus fare and lunch.

Astoria Generating Station, Consolidated Edison Company of New York, Inc., New York, N.Y. (Wednesday afternoon, Thursday morning and afternoon). Astoria station, newest and most efficient of Con Edison's nine steam-electric generating plants, is on the tidal East River in the Borough of Queens.

Ground was broken for the station in May 1951 at the height of the Korean War. Of the six generating units called for by its ultimate design, three are now in operation. Two of these are of 180 mw capacity (October 1953, March 1954) and the third (September 1958) has a nameplate rating of 335 mw. Foundation work has begun for a fourth unit of 340 mw which is tentatively scheduled for 1961.

Astoria is equipped to burn coal, oil, or natural gas. Of particular interest are the damper and nozzle arrangements to compensate for the station's relatively short stacks (because of nearby LaGuardia Airport) and the three-section DeLong prefabricated coal dock.

The electric station is part of a 312-acre complex of utility facilities which includes a major distribution point for natural gas from the Gulf Coast used by Con Edison and other gas utilities in the metropolitan area, extensive standby and peak-load gas manufacturing facilities, the North Queens bulk-power electric switching station, a fuel oil tank farm, and Con Edison's famous 2-million ton capacity coal storage yard.

General Motors (GM), Linden, N.J. (Tuesday afternoon). Here, at its Linden Plant, GM assembles Buick, Oldsmobile, and Pontiac automobiles. On a two shift operation, this plant turns out approximately 154,000 cars per year, employing an average of 4,500 men and women. Payroll, services, and material purchases from local suppliers, amount to approximately $30 million a year. An average of 1,200 freight cars of material are received each month.

One of seven similar units of GM's Buick–Oldsmobile–Pontiac Assembly Division, this plant officially began production in April 1937. During World War II, it produced fighter airplanes for the U.S. Navy.

The five main structures—manufacturing, administration, personnel, and cushion buildings and the power house—enclose almost 1,375,000 square feet of floor space. The plant occupies a site of more than 85 acres on U.S. Highway No. 1.

This is an assembly plant, not a fabricating plant. Here, the thousands of parts, metal stampings, and subassemblies manufactured in other GM and independent plants are brought together—each at exactly the right time and place on the assembly line—to produce nearly 40 different automobile models. These parts converge on Linden, not to be stockpiled for future use but, in many cases, to be moved directly from freight car to assembly line.

The Holophane Light and Vision Institute, New York, N.Y. (Wednesday afternoon). This trip offers visitors unusual insight into the science and art of lighting through the use of unique visual displays and demonstrations administered by a staff of competent engineers. Principles underlying quantity and quality of lighting, glare, color and many other interesting topics are effectively explained by means of visual models. Refreshments will be served.

International Business Machines Corp (IBM), New York, N.Y. (Wednesday morning and Thursday afternoon). IBM will demonstrate their type *705* electronic data processing machine and type *305* Ramac with a unique disk memory. Also there will be a film and discussion on the recently announced transistorized *7070* computer.

Leeds & Northrup Company (L&N), North Wales, Pa. (all day Wednesday). The newest L&N Plant, at North Wales known as one of the world's most modern instrument plants, manufactures various automatic instruments and controls, such as the Speedomax Recorders and Recorder-Controllers, L&N Load-Frequency Controllers, Metermax Combustion Control, and Electromax Controllers which are ultimately used in power and switching stations, open hearth furnaces, the metal working fields, atomic reactor installations aircraft industries, and others. The visitor will see the manufacture of many small parts and tools as well as the final assembly of units and the units into panels and consoles.

Bus leaves Statler 8:00 a.m., returns 5:30 p.m. Reservation $3.50.

Leviton Manufacturing Company, Inc., Brooklyn, N.Y. (Thursday morning). This company manufactures a complete line of wiring devices, cable, and fixtures. All component parts are made in the one plant, except wire and cable. A small testing laboratory is also on the premises.

New York Times, New York, N.Y. (Tuesday, Wednesday, and Thursday mornings).

CLOSE TO A MILLION WORDS OF NEWS are transmitted into this communications room of *The New York Times* every day. Teletype and telegraph machines are operating; telephone and short wave messages from around the world are recorded and later transcribed. An inspection trip to the *Times* will be held during the Winter General Meeting of the Institute.

Visit, in midtown Manhattan, the home of what is probably the most widely read newspaper in the world, *The New York Times*. View the various devices in the communications room of the *Times* that make it possible to have news transmitted from all over the world. See how the news is edited as well as the mechanical operations that are required before the finished paper is put on the street.

In the composing room, type setting machines are used to get the copy in a form necessary to create a "mat" which will be sent to the pressroom. The automatic plate casting machines as well as the presses themselves are found in the stereotype department. The presses at *The New York Times* can print 375,000 48-page papers in an hour.

Radio City Music Hall, New York, N.Y. (Tuesday morning). This ever-popular trip has been scheduled again. Spectacular stage shows distinguished by unique lighting effects have made the Radio City Music Hall an outstanding attraction for visitors from all over the world. Members will see the backstage facilities as well as unusual features, such as the revolving sectionalized stage, elevating orchestra pit, motorized curtains, and the multitude of electric and mechanical controls required for the special stage and lighting effects.

Rambusch Decorating Company, New York, N.Y. (Tuesday afternoon). The most diversified representation of artistry and craft work is found here. Designers, craftsmen, and lighting engineers work in complete shops and studios under one roof to serve architects and decorators with all phases of original design and execution of the decorative arts. Working in metal, wood, marble, glass, plastic, terra-cotta, and with light, paint, and mosaic, using all types of carving, paneling, and finishing equipment, skilled artisans create anything from medallions, candle sticks, and altars to murals, statues, and great stained, polished, or carved glass windows, using the most original lighting effects.

Some of Rambusch's many creations are: the lighting of the St. Louis Air Terminal Building; carved plate-glass windows in St. Thomas Moore Chapel of Yale University; bronze sculpture for the *S.S. United States;* the United Nations Metal Map in the World Assembly Hall; sand blasted tinted glass in the U.S. Coast Guard Academy Chapel, New London, Conn.; and the colored maparium glass enamel sphere of the Christian Science Publishing House, Boston, Mass.

Steinway & Sons, Astoria, N.Y. (Thursday afternoon). Visitors will see skilled craftsmen fitting the sound boards and iron frames of pianos, and stringing, installing, and regulating the keys and actions. They will also see finishing, polishing, and other specialized handiwork which is the heart of the piano. An unusual opportunity to witness the work of the master artisan.

Underwriters' Laboratories, New York, N.Y. (Wednesday morning). The Laboratories, sponsored by the National Board of Fire Underwriters, are operated for service, not for profit. They examine and test for public safety, write standards for safety, and control identification of their tested items, with markers, labels, lists, and listing cards.

The New York Laboratories tests electric equipment and fire alarm and signaling apparatus.

The tour will include viewing a short color movie showing some of the spectacular tests in slow motion. Interesting tests, such as destruction of new television sets, as well as routine tests will be programmed.

The opportunity to observe the interest and concern these men have in public safety coupled with their thoroughness is sure to offer an interesting tour.

The Underwriters' Laboratories is a foremost safety testing laboratory whose clients operate 6,500 plants turning out an estimated 1 billion safe-guarded articles each year.

United Nations General Assembly, New York, N.Y. (Tuesday morning). A guided tour of the United Nations General Assembly Building will take slightly over one hour covering various special facilities and functions of this building and descriptions of special details. It includes a trip through the Visitors' Gallery of the General Assembly Hall if the Assembly is in session. (Present United Nations schedule lists committee sessions only, and admission ticket, at no charge, will be available for optional group attendance after lunch about 2 p.m.) Arrangements may be made for group luncheon (not included in ticket) in the Delegates' Dining Room. The lunch is recommended but optional.

(The site of the new United Engineering Center Building will be pointed out, opposite the north end of the United Nations Plaza.)

Western Electric Company, Kearney, N.J. (all day Tuesday). This is one of the largest manufacturing plants of this supply organization for the Bell System. Included in this tour will be the multiconductor cable shop, relay blade manufacturing, and assembly of manual and automatic switchboard equipment.

Bus leaves Statler 9 a.m., returns 4 p.m. Reservation $2.50.

Ladies Entertainment

The Ladies Entertainment Committee hopes that it may greet many ladies at the Winter General Meeting and has arranged an interesting program for the week.

REGISTRATION: Ladies register with their husbands and obtain their name badges which are required for registering for the events of the Ladies Program. Registration for Ladies Events starts on Sunday afternoon from 2 to 4 p.m. in Ladies Headquarters and continues each day of the meeting.

Ladies Headquarters, in the Washington Room of Hotel Statler will be open throughout the week for registration, coffee hours, meeting friends, relaxing, and playing cards.

Coffee Hour in Ladies Headquarters will be held each morning, Monday through Friday.

PROGRAM: *Monday*—Get acquainted Tea sponsored by Phelps Dodge Copper Products Corporation. There will also be a fur fashion show presented by L. F. Gompertz, Inc. *Tuesday*—Sightseeing tour to lower Manhattan with a visit to the new Stock Exchange and a luncheon in Chinatown. In the evening, dinner with valuable door prizes preceded by a cocktail hour sponsored by ITE Circuit Breaker Company. Following dinner there will be a program of Musical Portraits sponsored by Waterbury Company, Inc. *Wednesday*—United Nations Tour with the option of having lunch in the Delegates' Dining Room. Children over nine years old may be taken on this tour. *Thursday*—Breakfast at Altman's Department Store followed by a millinery show; 12:30 luncheon and fashion show at the Waldorf-Astoria. There will also be door prizes. NOTE: Since this event is not sponsored, the number of tickets will not be limited, so that it will be possible to accommodate all ladies registered at the meeting. *Friday*—Arrangements can be made for a visit to the Interior Design Center or to Gompertz Fur Shop and luncheon at an interesting restaurant.

Registration Fees

The AIEE Board of Directors have arranged for a special registration fee to be tried out at the 1959 Winter General Meeting for those wishing to attend only a few sessions. A one-day registration fee of $2, for members and nonmembers alike, will be available on arrival at the meeting. The full-week registration fee will remain unchanged. No advance fee will be accepted for either one-day or full-week registrations.

Winter General Meeting Committee

Members of the 1959 Winter General Meeting Committee are: R. T. Weil, Jr., chairman; R. W. Gillette, vice-chairman; J. J. Anderson, secretary; J. R. Kerner, budget co-ordinator and AIEE vice-president for District No. 3; C. T. Hatcher, chairman, Technical Operations Department; J. A. Parrott, public relations; W. T. Rea, general session; D. E. Winslow, hotel accommodations; T. C. Oliver, registration; H. G. Koch, inspection trips; Arvin Grabel, monitors; D. Halloran, smoker; E. J. Doyle, dinner-dance; Mrs. D. M. Quick, ladies entertainment; D. M. Quick, ex-offico member (past-chairman).

Fifth National Symposium on Reliability and Quality Control

Sponsored by AIEE, Institute of Radio Engineers (IRE), American Society for Quality Control (ASQC), and Electronic Industries Association (EIA), the Fifth National Symposium on Reliability and Quality Control will be held January 12-14, 1959, at the Bellevue-Stratford Hotel in Philadelphia, Pa.

Inspection tours, planned for Wednesday afternoon, include: SAGE Site Operations—Burroughs Corporation; Automated Television Assembly Lines—Philco Corp.; Transistor Production Operations—Philco

Corp.; and Fairless Works—United States Steel Co.

Advance registration fee is $18 for AIEE, IRE, and ASQC members, and $20 for all others. January 5, 1959, is the final date for receipt of advance registration fees which should be addressed to James Rivera, RCA Service Company, Government Service Department 204-1, Cherry Hill, Camden 8, N. J. Door registration will be $22.

Following is an outline of the sessions to be held during the Conference.

Monday, January 12

9:00 a.m. Session 1—Keynote Address

"Reliability and Air Weapons Systems," Maj. Gen. W. T. Thurman, USAF, assistant for production programming to Deputy Chief of Staff, Materiel

10:00 a.m. Session 2A—Reliability of Transistorized Equipment

10:00 a.m. Session 2B—Cost of Reliability

2:00 p.m. Session 3A—Military/Industry Reports

2:00 p.m. Session 3B—Mathematical Theory

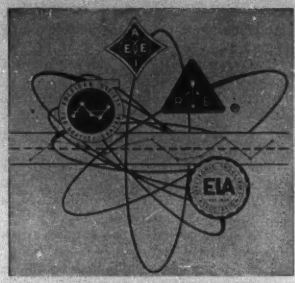
1:00 p.m. Session 3C—Tutorial Session on the Fundamentals of Reliability

7:30 p.m. Session 4—Reliability Definitions Panel

Tuesday, January 13

9:00 a.m. Session 5A—Reliability Training and Education

9:00 a.m. Session 5B—Quality Control Techniques



AIEE, Institute of Radio Engineers, American Society for Quality Control, and Electronic Industries Association will join together in sponsoring the fifth National Symposium on Reliability and Quality Control in Electronics.

2:00 p.m. Session 6A—Techniques for Reliable Design

2:00 p.m. Session 6B—Field Reliability and Maintainability

6:00 p.m. Symposium Reception & Banquet

Address: "Is Your Customer Satisfied?" Capt. D. R. Hull (USN, Ret.), president, EIA, and vice-president, Raytheon Manufacturing Co.

Wednesday, January 14

9:00 a.m. Session 7A—Reliability Tests and Measurements

9:00 a.m. Session 7B—Reliability Management

United Engineering Trustees, Inc. Annual Report for the Year 1957-58

THE ANNUAL REPORT of the Corporation and its Departments, for the fiscal year October 1, 1957, to September 30, 1958, has been issued by United Engineering Trustees, Inc. (UET).

UET was established in 1904 by joint action of three national engineering societies: American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (AIME). The American Society of Mechanical Engineers (ASME), and AIEE, which thereupon became the Founder Societies. In 1916, the American Society of Civil Engineers (ASCE) became a fourth Founder Society, and on May 1, 1958, the American Institute of Chemical Engineers (AIChE) was admitted as a fifth Founder Society. The Corporation's charter gives it broad powers for the advancement of the engineering arts and sciences in all their branches, including the maintenance of a free public engineering library.

The corporate powers and responsibilities are exercised by a Board of 15 Trustees, three from each Founder Society, to which all departments of the Corporation (Engineering Societies Library, Engineering Foundation, and Engineering Societies Building) are responsible. The Corporation is legally empowered to conduct such combined activities for the Societies as may be desired by the Founders.

The President's Report

Among the contents of the Annual Report is "The President's Report to the Board of Trustees and the Founder Societies for the 54th Year of United Engineering Trustees, Inc., 1957-58," the text of which follows. (Serving as UET president for 1957-58 was W. J. Barrett, past president of the AIEE.)

General

UET, as the joint corporate agency of the Founder Societies, is responsible for the administration of large trust funds for the advancement of the engineering arts and sciences. In furthering its Charter objectives, UET is now fully launched on a program of providing for the major national engineering societies a new national headquarters which can fully and adequately serve an expanding technology. When the present Engineering Societies Building was dedicated in 1907, the Founder Societies listed membership totaled 15,539. Today, the Founder Societies membership lists (including AIChE) total more than 186,000 and are rapidly growing.

AIChE—Fifth Founder Society

Late in 1956, basis for admission of the AIChE as a fifth Founder Society was approved by the governing bodies of the Founder Societies and AIChE. Subsequently, with crystallization of plans for the new Center, formal Founders', Supplemental, and Library Agreements were prepared and approved by the five governing bodies. By May 1, 1958, all agreements were signed by the Presidents of the five Societies and UET, and on that date the AIChE became a fifth Founder Society in UET. The following constitutes the basis of Agreement for admission of AIChE as a fifth Founder Society in UET:

AIChE shall be entitled to appoint or elect the same number of Trustees to serve on the Board of UET as each of the other Founder Societies.

AIChE will contribute the sum of $50,000 to UET. Each of the four present Founder Societies shall be considered as contributing the sum of $265,000, representing amounts heretofore contributed by these Societies.

Interest shall be paid to each of the five Societies at the rate of 4% per annum on the aforesaid contributions.

AIChE support of the Library will begin when the new building is ready for occupancy.

We are happy to include AIChE as Corporate member since our corporate structure and objectives are substantially strengthened.

United Engineering Center

Site. By the beginning of the present fiscal year, UET had acquired title to 34,000 square feet of the United Engineering Center site, and had executed a purchase contract for the remaining 3,500 square feet. On October 1, 1958, title to the remaining 3,500 square feet was acquired. The site includes the entire block front on the West side of United Nations Plaza between East 47th and East 48th Streets and extends back from First Avenue for 150 feet on East 47th Street and for 225 feet on East 48th Street.

Some 85% of the land has been cleared of buildings and the site prepared for construction. Of the remaining 15% of the land, only the gasoline station on the corner of United Nations Plaza and 48th Street is occupied, and, under agreement, this property was to be vacated by December 18, 1958.

The total cost of the land for the building site, including site preparation and legal expenses, is computed to be $2,743,000. The cost of this land was covered by the real estate assets of UET consisting of the market value of the present Engineering Societies Building and the accumulated Depreciation Reserve.

The New Building. The new building is

(Continued on page 91)

Schedule of AIEE General and District Meetings

MEETING DESIGNATION		NAME OF MEETING	CONVENTIONAL SCHEDULE	1959			1960			1961			1962			1963			1964			INVITATIONS	
				DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION
GENERAL	WG	WINTER	FEB. 1ST WEEK	FEB. 1-6	NEW YORK, N.Y.	NOV. 3 1958	JAN. 31 FEB. 5	NEW YORK, N.Y.	NOV. 2 1959	JAN. 29 FEB. 3	NEW YORK, N.Y.	NOV. 1 1960	JAN. 28 FEB. 2	NEW YORK, N.Y.	OCT. 30 1961	JAN. 27 FEB. 1	NEW YORK, N.Y.	OCT. 29 1962	FEB. 2-7	NEW YORK, N.Y.	OCT. 14 1963		NEW YORK
																						65	1/31-2/5 OR 2/7-2/12
	SG	SUMMER	JUNE 3RD 4TH WEEK	JUNE 21-26	SEATTLE, WASHINGTON	MAR. 23 1959	JUNE 19-24	ATLANTIC CITY, N.J.	MAR. 22 1960	JUNE 18-23	ITHACA, N.Y.	MAR. 20 1961	JUNE 17-22	DENVER, COLO.	MAR. 19 1962		TORONTO, CANADA			LOS ANGELES		85	MIAMI BEACH
	PG	PACIFIC	AUG.				AUG. 8-12	SAN DIEGO, CALIF.	MAY 10 1960	AUG. 23-25	SALT LAKE CITY, UTAH	MAY 25 1961		SAN FRANCISCO CALIF.		AUG. 20-23	SPOKANE, WASH.	MAY - 23					
	FG	FALL	OCT.	OCT. 11-16	CHICAGO, ILL.	JUNE 12 1959	OCT. 9-14	CHICAGO, ILL.	JUNE 10 1960	OCT. 15-20	DETROIT, MICH.	JUNE 14 1961		CHICAGO, ILL.			CHICAGO, ILL.			CLEVELAND, OHIO (TENTATIVE)			
DISTRICT	D1	EMPIRE	EARLY MAY	APR. 29 MAY 1	SYRACUSE, N.Y.	JAN. 29 1959																	
	D2	MIDDLE EASTERN	MAY	MAY 19-21	BALTIMORE, MD.	FEB. 16 1959		(SGM)		MAY 2-4	PITTSBURGH, PA.	FEB. 1 1961	MAY 14-16	ERIE, PA.	FEB. 13 1962									
	D4	SOUTH EAST	LATE MAR. EARLY APR.	APR. 8-10	ATLANTA, GA.	JAN. 5 1959				APR. 5-7	NEW ORLEANS, LA.	JAN. 2 1961					MIAMI BEACH, FLA.						
	D5	GREAT LAKES	LATE APR.				APR. 27-29	MILWAUKEE, WISC.	JAN. 27 1960	APR. 19-21	MINNEAPOLIS, MINN.	JAN. 19 1961	APR. 18-20	FORT WAYNE, IND.									
	D7	SOUTH WEST	LATE MAR. EARLY APR.				APR. 4-6	HOUSTON, TEXAS	JAN. 4 1960				APR. 30 MAY 2	ST. LOUIS, MO.									
	D11	EAST CENTRAL	EARLY MAY	APR. 22-24	AKRON, OHIO	JAN. 22 1959	MAY 10-12	CHARLESTON, W.VA.	FEB. 10 1960	MAY 9-11	CLEVELAND, OHIO	FEB. 8 1961	MAY 23-25	TOLEDO, OHIO		MAY 7-9	COLUMBUS, OHIO (TENTATIVE)		MAY 5-7	DETROIT, MICH. (TENTATIVE)			
	D12	NORTH EASTERN	EARLY MAY				MAY 2-4	PROVIDENCE, R.I.	FEB. 1 1960	MAY 17-19	HARTFORD, CONN.	FEB. 16 1961	MAY 9-11	BOSTON, MASS.	FEB. 8 1962	MAY 14-17	PORTSMOUTH, N.H. OR PORTLAND, ME. (TENTATIVE)						
	D13	SOUTH CENTRAL	LATE MAR. EARLY APR.	APR. 8-10	JOINT WITH D4 ATLANTA, GA.	JAN. 8 1959				APR. 5-7	JOINT WITH D4 NEW ORLEANS, LA.	JAN. 2 1961					JOINT WITH D4 MIAMI BEACH, FLA.						
EASTER				MARCH 29			APRIL 17			APRIL 2			APRIL 22			APRIL 14			MARCH 29			

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
1959-1964 SCHEDULE OF GENERAL & DISTRICT MEETINGS

ISSUED BY:
J.D. TEBO
CHAIRMAN

Schedule of Special Technical Conferences

Date	Conference and Location	Sponsors
1959		
Sept. 30-Oct. 1	Industrial Electronics	AIEE-IRE
Sept. 30-Oct. 2	National Power, Muehlebach Hotel, Kansas City, Mo.	AIEE-ASME
Oct. 12-14	National Electronics, Chicago, Ill.	AIEE-IRE-EIA-SMPTE
Oct. 19-21	Machine Tools, Hotel Cleveland, Cleveland, Ohio	AIEE Machine Tools Subcommittee
Nov. 16-19	Magnetism and Magnetic Materials Sheraton Cadillac Hotel, Detroit, Mich.	AIEE Magnetics Subcommittee
Nov. 30.-Dec. 3	Eastern Joint Computer, Statler Hotel, Boston, Mass.	AIEE-IRE-ACM
1960		
Feb. 11-12	Transistor and Solid-State Circuits, University of Pennsylvania, Philadelphia, Pa.	AIEE-IRE-U of P
April 3-8	Nuclear Engineering Congress, New York, N. Y.	AIEE-ASME-EJC
April 18-20	Automatic Techniques, Cleveland, Ohio	AIEE-ASME-IRE
May 10-12	Farm Electrification, Omaha, Nebr.	AIEE Rural Electrification Subcommittee
May 17-19	Electrical Problems in the Cement Industry, Milwaukee, Wis.	AIEE Cement Industry Subcommittee
Aug. 8-12	Air Transportation (at Pacific General Meeting), San Diego, Calif.	AIEE Air Transportation Committee
Sept. 21-22	Industrial Electronics	AIEE-IRE
Sept. 26-28	Petroleum Industry, Skirvin Hotel, Oklahoma City, Okla.	AIEE Petroleum Industry Committee
Oct. 10-12	National Electronics, Chicago, Ill.	AIEE-IRE-EIA-SMPTE
Nov. 14-17	Magnetism and Magnetic Materials, Hotel New Yorker, New York, N. Y.	AIEE Magnetics Subcommittee
Dec. 11-14	Eastern Joint Computer, Hotel New Yorker, New York, N. Y.	AIEE-IRE-ACM

AIEE Future Meetings

AIEE-IRE-ASQC-EIA National Symposium on Reliability and Quality Control*
Bellevue-Stratford Hotel
Philadelphia, Pa.
January 12-14, 1959

Winter General Meeting*
Statler Hotel
New York, N. Y.
February 1-6, 1959

AIEE-IRE-U of P Transistor and Solid-State Circuits Conference
University of Pennsylvania
Philadelphia, Pa.
February 12-13, 1959

AIEE-IRE-ACM Western Joint Computer Conference
Fairmont Hotel
San Francisco, Calif.
March 3-5, 1959

AIEE-ASME-IIT American Power Conference
Sherman Hotel
Chicago, Ill.
March 31-April 2, 1959
(Final date for †TP—closed, ‡CP Syn.—Jan. 16, CPMs—Jan. 26)

Spring Textile Conference
Atlanta, Ga.
April 2-3, 1959
(Final date for †TP—Jan. 2, ‡CP Syn.—Jan. 16, CPMs—Jan. 27)

EJC Nuclear Congress
Municipal Auditorium
Cleveland, Ohio
April 5-10, 1959

AIEE-AWS Electric Welding Conference
Chicago, Ill.
April 6-10, 1959
(Final date for †TP—Jan. 6, ‡CP Syn.—Jan. 20, CPMs—Jan. 30)

AIEE-ASME Railroad Conference
Chicago, Ill.
April 7-9, 1959
(Final date for †TP—Jan. 7, ‡CP Syn.—Jan. 23, CPMs—Feb. 2)

Southern District Meeting
Dinkler Plaza Hotel
Atlanta, Ga.
April 8-10, 1959
(Final date for †TP—Jan 8, DPMs—Feb. 2)

Electric Heating Conference
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 14-15, 1959
(Final date for †TP—Jan 14, ‡CP Syn.—Jan. 30, CPMs—Feb. 9)

Electrical Problems in the Cement Industry Conference
Americus Hotel
Allentown, Pa.
April 15-16, 1959
(Final date for †TP—Jan. 15, ‡CP Syn.—Jan 30, CPMs—Feb. 9)

Recording and Controlling Instruments Conference
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 20-21, 1959
(Final date for †TP—Jan. 20, ‡CP Syn.—Feb. 3, CPMs—Feb. 13)

East Central District Meeting
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—Jan. 22, DPMs —Feb. 16)

Rubber and Plastics Conference
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—Jan. 22, ‡CP Syn.—Feb. 6, CPMs—Feb. 16)

Empire District Meeting
Hotel Syracuse
Syracuse, N. Y.
April 29-May 1, 1959
(Final date for †TP—Jan. 29, DPMs —Feb. 23)

AIEE-IRE-EIA-WCEMA Joint Electronic Components Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
May 6-8, 1959
(Final date for †TP—Feb. 5, ‡CP Syn.—Feb. 20, CPMs—March 2)

AIEE-ASME-IRE Automatic Techniques Conference
Hotel Manger
Chicago, Ill.
May 11-13, 1959
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 24, CPMs—March 6)

Domestic Appliances Conference
Pick-Carter Hotel
Cleveland, Ohio
May 18-19, 1959
(Final date for †TP—Feb. 17, ‡CP Syn.—March 3, CPMs—March 13)

Middle Eastern District Meeting
Lord Baltimore Hotel
Baltimore, Md.
May 19-21, 1959
(Final date for †TP—Feb. 18, DPMs —March 13)

AIEE-ISA-ARS-IAS National Telemetering Conference
Brown Palace and Cosmopolitan Hotel
Denver, Colo.
May 24-27, 1959
(Final date for †TP—Feb. 23, ‡CP Syn.—March 10, CPMs—March 20)

Paper and Pulp Conference
University of Maine
Orono, Maine
June 18-19, 1959
(Final date for †TP—March 20, ‡CP Syn.—April 3, CPMs—April 14)

Summer and Pacific General Meeting
Olympic Hotel
Seattle, Wash.
June 21-26, 1959
(Final date for †TP—March 23, ‡CP Syn.—April 7, CPMs—April 17)

Petroleum Industry Conference
Wilton Hotel
Long Beach, Calif.
August 25-27, 1959
(Final date for †TP—May 27, ‡CP Syn.—June 12, CPMs—June 23)

AIEE-NEMA National Electrical Insulation Conference
Chicago, Ill.
September 9-11, 1959
(Final date for †TP—June 11, ‡CP Syn.—June 26, CPMs—July 6)

AIEE-ASME Engineering Management Conference
Statler Hotel
Los Angeles, Calif.
September 16-18, 1959
(Final date for †TP—June 18, ‡CP Syn.—July 3, CPMs—July 13)

Magnetic Amplifiers Conference
Shoreham Hotel
Washington, D. C.
September 23-25, 1959
(Final date for †TP—June 25, ‡CP Syn.—July 10, CPMs—July 20)

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 11-16, 1959
(Final date for †TP—June 12, ‡CP Syn.—July 30 CPMs—Aug. 7)

*Final date for submitting papers—closed

†TP—Transactions Paper

‡CP Syn.—Conference Synopsis

CPMs—Conference Manuscript

DPMs—District Manuscript

(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Authors Guide*.
For a copy, write to E. C. Day, AIEE, 33 W 39th St., New York 18, N.Y.

(*Continued from page 88*)

estimated to cost approximately $8 million. These funds are being raised in the form of contributions from industry and individual membership of the engineering societies.

The Center will meet in full all present requirements of Founder and Associate Societies. The design provides for expansion with the continuing growth of the engineering profession and the even greater service essential for future generations. As necessary, it will incorporate every advanced feature and facility that engineering can provide.

The architects, Shreve, Lamb & Harmon Associates, are now completing preliminary drawings for the new United Engineering Center. The building is planned to be 20 stories in height in addition to penthouse and basement spaces. Gross floor area of the structure will be approximately 280,000 square feet. Above a two-story base, the building will rise in a tower type structure approximately 65 feet by 140 feet in plan.

The basement, first and second floors of the building will house the jointly used facilities of the Societies, including the cafeteria, private dining rooms, exhibit hall, large meeting room to seat 400 persons, the Engineering Library with accessory spaces, and Central Service Offices for duplicating, shipping, etc., all facing an attractive landscaped interior court or the street fronts.

Expansion of floor space in the future will be in a wing to be constructed to the north along 48th Street where the structural frame will be designed for additional floors.

The building will be completely air conditioned with special humidity and temperature control of the Library stack areas. Fans for office floors, air conditioning absorption machines, and cooling tower are located in the penthouse, while fans and other equipment for the lower special rooms will be placed in the basement. Five high-speed automatic elevators are planned for the first construction stage. Structural engineers on the project are Seelye, Stevenson, Value & Knecht; mechanical engineers are Jaros, Baum & Bolles.

Fund Raising

It is expected that the building will be ready for occupancy approximately January 1, 1961. Completion of the new Center is dependent on raising the necessary funds from industry and society membership.

The $8 million needed to erect the new building is being raised by three fund raising campaigns which were organized during the year: an Industry Gifts Campaign, Member Gifts Campaign, and a Greater New York Business Campaign. The Industry Gifts Campaign is to raise $5 million and the Member Gifts Campaign $3 million.

Industry Gifts Campaign. The Industry Campaign, under the Chairmanship of Dr. M. J. Kelly, president of Bell Telephone Laboratories, Inc., was launched at a dinner meeting of more than 100 of America's leading industrialists at the Waldorf Astoria Hotel on November 21, 1957; the dais included the Honorable Herbert Hoover, J. R. Killian, Jr., D. A. Quarles, R. J. Cordiner, and A. P. Sloan, Jr.

Dr. Kelly keynoted the Industry Campaign "kickoff" when he said: "This new facility (the new United Engineering Center) is a must for the societies, industry, and the nation. It must be financed. The members of the societies and industry are the sources of the funds. I am confident their response will provide the amount required."

The Honorable Herbert Hoover is honorary chairman and A. P. Sloan, Jr., is honorary vice-chairman of the Industry Gifts Campaign.

Organization of this Campaign has followed both regional and functional lines with significant leadership from distinguished members of the Founder Societies.

Evidence of industrial acceptance of the new Center lies in the widely diversified fields of corporate activity of subscribers to date: automotive, electrical manufacturing, oils, nonferrous metals, steels, public utilities, chemicals, and communications.

As of October 17, 1958, America's leading corporations have subscribed $3,522,833 of the $5 million goal.

Member Gifts Campaign. Organization of the Member Gifts Campaign started November 21, 1957, when R. E. Dougherty, past president of ASCE, accepted appointment as general chairman.

C. F. Kettering is honorary chairman and the Presidents of the five Founder Societies are honorary vice-chairmen.. Co-Chairmen for the Member Gifts Campaign are: Enoch Needles, ASCE; J. L. Gillson, AIME; W. F. Ryan, ASME; Lester Goldsmith, AIEE; and Walter Whitman and S. D. Kirkpatrick, AIChE.

Prior to Labor Day 1958, the societies' leadership was engaged in the selection and some solicitation of advance gifts prospects and in the building of an organization for individual solicitation of their members on a national basis. The extent of this organizational effort became apparent shortly after Labor Day when there was a sharp upsurge in the number of subscriptions arriving at campaign headquarters and a consequent acceleration in total dollar attainment.

As of October 17, 1958, over $740,000 had been subscribed toward the $3 million goal.

Greater New York Business Campaign. Late in 1957, a third fund raising campaign was organized when W. H. Byrne, vice-president of ASME, accepted the general chairmanship of the Greater New York Business Campaign. The Honorable R. F. Wagner, Mayor of the City of New York, is designated as honorary chairman.

On May 2, 1958, the campaign had a "kickoff" luncheon at the Waldorf Astoria which was attended by many of New York City's outstanding civic leaders.

As of October 17, 1958, this campaign had secured pledges totaling $120,800.

Associate Societies in the New Engineering Center

The Board of Trustees has decided that only those organizations enjoying a 501 (c) (3) tax classification may occupy space in the new building. Societies other than Founder Societies occupying space in the new building shall be known as Associate Societies. Prospective Associate Societies which have expressed an interest in participating in the new United Engineering Center are: American Institute of Consulting Engineers, American Institute of Industrial Engineers, American Society of Refrigerating Engineers, American Welding Society, American Society of Heating and Air-Conditioning Engineers, and Society of Women Engineers. Several other prospective Associates are, for various reasons, not yet in a position to commit themselves.

The Board of Trustees has determined that space assessment rates will be uniform for the societies' headquarters office space with no distinction between Founder and Associate Societies. In addition to Engineering Societies Library and Engineering Foundation, other joint bodies which have shown interest in being accommodated in the new Center are: Engineers Council for Professional Development, Engineering Index, National Council of State Boards of Engineering Examiners, Welding Research Council, and Engineers Joint Council.

The responsibility for management, construction, and administration of the United Engineering Center will rest with the Board of Trustees. However, operation of the Center will be handled by a Management Committee with representation from both Founder and Associate Societies; one of the principal responsibilities of this Management Committee will be to recommend to the Board of Trustees, from time to time, proper space assessment rates.

Similarly, it is anticipated that the Associate Societies will have a voice in the management of the Library and will share in its financial support on a uniform basis.

Engineering Societies Library

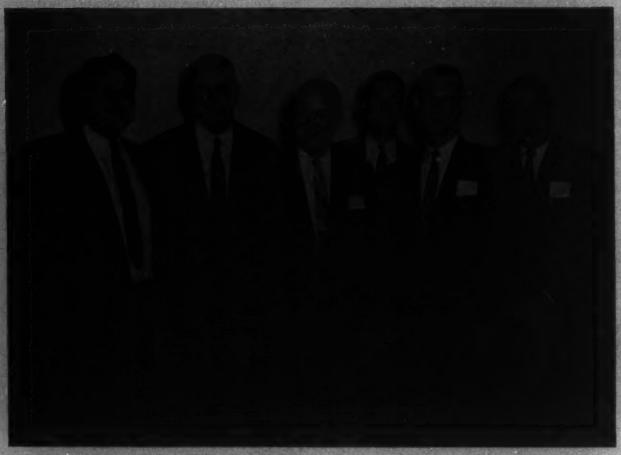
Recognizing that the strength of our technology depends to a large extent upon the organization and availability of the world's engineering literature, the Engineering Societies Library, as the educational arm of UET, endeavors to provide engineers with a type of service unmatched elsewhere in the world. Evidence of the usefulness of the Library is demonstrated by a 19% increase in use of the Library during the 1957-58 year. Covering the various languages of the world, the Library's collection is outstanding in all fields of engineering.

The Library Board has already initiated specific planning which will permit the development of an even more useful Library in the proposed new United Engineering Center. With the expansion of facilities, the Library will be able to extend still further the quantity and the quality of its services to all engineers and to industry.

Engineering Foundation

The Engineering Foundation, as the research department of UET, utilizes income from its own endowment in order to

Pittsburgh Section Building Fund Drive



THE AIEE PITTSBURGH SECTION'S kick-off smoker held Monday evening, September 22, 1958, opened the Section's Building Fund Drive for the new United Engineering Center. Taking an active part in the meeting were *(left to right)*: Dr. B. R. Teare, Jr., vice-president, AIEE District No. 2, and dean of engineering at Carnegie Institute of Technology; A. C. Monteith, past president of AIEE and vice-president of Westinghouse Electric Corporation; M. B. Wyman, chairman of the Member Gifts Committee; W. R. Harris, 1958-59 chairman of the Pittsburgh Section; A. A. Johnson, director, AIEE District No. 2, and former Section chairman; and R. N. Wagner, general chairman, Pittsburgh Section Fund Drive, and immediate past chairman of the Section.

stimulate basic research of broad importance to the Founder Societies.

During the past year, Engineering Foundation grants of approximately $80,000 have resulted in industry support of projects totaling some $600,000.

As of this writing, the Engineering Foundation Board is carefully re-examining its policies and concepts in order to determine whether there may be other areas of endeavor in which its funds may be used more effectively.

Medal Boards

UET is custodian of two medal awards: the John Fritz Medal Award "for scientific or industrial achievement in any field of pure or applied science," and the Daniel Guggenheim Medal Award for "notable achievements in the advancement of aeronautics." The John Fritz Medal is administered jointly by ASCE, AIME, ASME, and AIEE, and the Daniel Guggenheim Medal is administered by ASME, Society of Automotive Engineers (SAE), and Institute of Aeronautical Sciences (IAS).

The 1959 recipient of the John Fritz Medal is Dr. M. J. Kelly for his achievements in electronics, leadership of a great industrial research laboratory, and contributions to the defense of the country through science and technology.

The 1958 recipient of the Daniel Guggenheim Medal is William Littlewood, vice-president–equipment research, American Airlines, for leadership and continuous personal participation over a quarter of a century in developing the equipment and operating techniques of air transport.

Finances

As of the end of the fiscal year 1957-58, UET's Balance Sheet Assets totaled some $6.7 million, an increase of $0.9 million over the previous fiscal year. The total real estate assets of UET are listed as $4.4 million, and the current real estate obligations (including United Engineering Center) total $695,246, which represents Founder Society Notes, mortgages, and real estate taxes.

UET's investments, excluding current funds and Agency Funds, are represented by three investment portfolios: Combined Fund, Blanche H. McHenry Memorial Fund, and the Depreciation Fund. The Combined Fund totals approximately $2.17 million of which 83% or $1.80 million is held in trust for the Engineering Foundation, and the remaining 17% or $370,000 is held in trust for the Engineering Societies Library. No part of the principal of the Combined Fund may be used by either department. An additional portfolio, the Blanche H. McHenry Memorial Fund, is held in trust for Engineering Foundation and it totals some $431,755 market value; this principal must also remain intact. The Depreciation Fund, totaling $520,284 market value, is a property fund which can readily be liquidated in connection with the United Engineering Center project. It is composed mainly of U.S. Treasury securities and American Telephone and Telegraph stock. The income based on book value of these Funds during the year is as follows: Combined Fund—5.66%, Blanche H. McHenry Memorial Fund—3.67%, Depreciation Fund—2.83%.

The United Engineering Center invested funds total $349,002 which are represented by U.S. Treasury Bills that can be quickly converted into cash. Fund raising pledges up to September 30, 1958, total some $4,169,888 of which $1,840,969 represents cash actually received.

All securities are held in custody by the Chemical Corn Exchange Bank, Customers' Securities Department. All accounts are audited twice yearly by Haskins and Sells, Certified Public Accountants.

Professional Advisers

Advisers are retained by the Board of Trustees on all phases of its work in order to obtain the best information available: Financial Counsel—W. B. Cummings, vice-president, Chemical Corn Exchange Bank; Investment Adviser—Wood, Struthers & Company, M. S. Harrison, Partner; Legal Counsel—Simon Presant; Consulting Architects—Shreve, Lamb & Harmon Associates; Consulting Actuary—G. B. Buck; Insurance Counsel—Frank & DuBois; Auditors—Haskins & Sells, Certified Public Accountants.

We are deeply appreciative to these advisers for their wise counsel in the handling of the affairs of the Corporation.

Appreciation

I wish to thank all members of the Board of Trustees for their wise counsel and outstanding achievements during my period as President. On their behalf sincere thanks are extended to the entire UET staff including Engineering Societies Library and Engineering Foundation for their outstanding work in the conduct of the affairs of the Corporation during the past four years.

Respectfully submitted,
Walter J. Barrett
President

Contents

Also contained in the UET Annual Report are Board and Committee lists for the Corporation and its Departments; individual reports of the Engineering Societies Library and the Engineering Foundation; and the Auditors' Report for 1957-58 which includes Accountant's Certificate, Balance Sheet, Statement of Changes in Funds, United Engineering Center Land Account, United Engineering Center Contributed Capital, Statement of Endowment Funds, Engineering Societies Building Operations, Engineering Societies Library Operations, Engineering Foundation—Research, Statement of Medal Awards, Statement of Agency Funds, Statement of Depreciation Reserve.

Those interested in obtaining a copy of the Annual Report should write to S. W. Marras, Secretary and General Manager, United Engineering Trustees, Inc., 29 W. 39th St., New York 18, N. Y.

Andrew Fletcher Named New President of UET

Andrew Fletcher, president of St. Joseph Lead Company, has assumed the additional responsibilities of President of United Engineering Trustees, Inc. (UET)

UET was incorporated in 1904 for the purpose of advancing the engineering arts and sciences. Its Board is composed of three representatives from each of the five professional societies representing the major branches of engineering—mechanical, civil, electrical, mining, and chemical. Among other activities, the Corporation directs the research programs of the Engineering Foundation, which is financed by a fund of over $2 million and also acts in a fiduciary capacity for many joint activities of the major engineering societies.

UET has purchased the block front between 47th and 48th Streets on the United Nations Plaza for the construction of a 20-story Engineering Center, the cost of which is roughly estimated at $10 million. Their present home on West 39th Street will be sold, and the Engineering Societies Library will move into the new Center; there the Library can greatly expand the services that have already made it one of the finest public engineering libraries in the country, if not in the world.

In order to bring the benefits of centralized activities in the new Engineering Center to as widespread a group of engineers as possible, the five societies of UET have extended invitations to other engineering societies to unite with them in using the new facilities as their headquarters. Thoroughly modern in every respect, the new Center will include, in addition to headquarters office space for each group, such facilities as a cafeteria, dining rooms, meeting rooms, and a large memorial hall, suitable for group meetings or for major exhibitions of technical progress. Few, if any, societies or groups in the world will then possess headquarter facilities as impressive in appearance and as efficient in operation as the engineers.

Mr. Fletcher is a past president of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), and in 1957, he was awarded the Charles F. Rand Gold Medal of AIME for "distinguished administration in nonferrous mining and metallurgical enterprises." He is also chairman of the Industrial Hygiene Foundation of America, vice-president and treasurer of the American Mining Congress, and past president of Lead Industries Association.

Mr. Fletcher succeeds W. J. Barrett of New Jersey Bell Telephone Company who has been President of UET since 1955 and who is also past president of the AIEE. In commenting on the new Center, Mr. Fletcher said:

"The progress made during the administration of Walter Barrett in planning the new United Engineering Center, securing the site opposite the United Nations, and launching the fund raising drives is an inspiration to unified effort such as the engineering profession has not had before.

"Under the leadership of W. F. Thompson and the Real Estate Committee, detailed plans for the building are being developed by Shreve, Lamb and Harmon, architects. It is expected that actual construction will be started in 1959, upon the completion of the fund-raising campaign in which $5 million will be obtained from business and industry, and $3 million from the 200,000 individuals who constitute the Engineering Societies membership. Already more than half the $8 million goal has been subscribed."

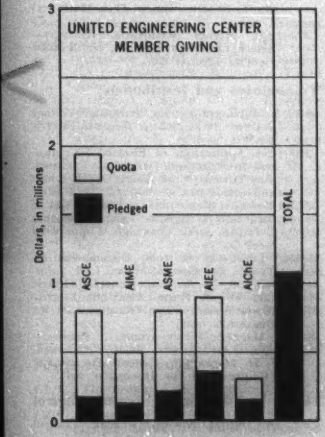
Fabian Bachrach

Andrew Fletcher

Other officers elected by UET are: G. W. Burpee and W. F. Thompson, vice-presidents; C. B. Molineaux, treasurer; and S. W. Marras, secretary-general manager.

Mr. Fletcher is a member of Society of Naval Architects and Marine Engineers, Yale Engineering Association, Mining and Metallurgical Society, Institute of Metals (London), Australasian Institute of Mining and Metallurgy (Melbourne).

Progress Toward the New United Engineering Center



THE BAR GRAPH (left) shows the status of member giving as of November 14, 1958. All contributions to the UET Building Fund are tax deductible.

DISCUSSING the Building Fund Campaign at the site of the new United Engineering Center on United Nations Plaza in New York City are *(left to right)*: W. J. Barrett, past president of United Engineering Trustees, Inc. (UET); C. H. Linder, a trustee of UET; and C. E. Davies, executive director of the United Engineering Center project.

Papers Which Were Planned for the AIEE Fall General Meeting

A LISTING FOLLOWS of the papers which were scheduled to be presented at the 1958 AIEE Fall General Meeting which was cancelled due to a hotel employees strike in Pittsburgh, Pa. Copies of numbered papers are available to members for 40¢ each and to nonmembers for 80¢ each. Send order and remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y. Papers marked CP* have not been printed by the Institute.

Data Communication

58-1181. Optimum Block Length for Data Transmission with Error Checking. *F. B. Wood*, International Business Machines Corp.

58-1240. Assessment Effects of Delay Distortion in Data Systems. *A. D. Fowler, R. A. Gibby*, Bell Telephone Labs., Inc.

CP58-1241. Measurements of Narrow Band Noise on Telephone Facilities in Connection with Analog Data. *J. O. Edson, F. E. Froelich, R. K. Townley*, Bell Telephone Labs., Inc.

58-1204. An FM Digital Subset for Data Transmission over Telephone Lines. *L. A. Weber*, Bell Telephone Labs., Inc. (Represented for Discussion only)

58-300. Synchronized Clocks for Data Transmission. *J. O. Edson, M. A. Flaven, A. D. Perry*, Bell Telephone Labs., Inc. (Re-presented for Discussion only)

58-302. SAGE Data System Considerations. *R. G. Enticknap*, Massachusetts Institute of Technology; *E. F. Schuster*, Western Electric Co., Inc. (Re-presented for Discussion only)

58-407. SAGE Data Terminals. *R. O. Soffel, E. G. Spack*, Bell Telephone Labs., Inc. (Re-presented for Discussion only)

58-332. Communication Channels for SAGE Data Systems. *R. T. James*, American Telephone & Telegraph Co. (Re-presented for Discussion only)

Nuclear Instrumentation and Control

CP58-1257. Coolant Instrumentation for Pressurized Water Reactor Power Plants. *J. J. Lihota, C. B. Hoppa*, Westinghouse Electric Corp.

CP58-1319. A Rod Position Indication System for Pressurized Reactors. *R. C. Floyd, J. F. Reuther*, Westinghouse Electric Corp.

58-1329. The Design of a Pile Oscillator for the Ford Nuclear Reactor. *J. Stone, W. Kerr*, University of Michigan. (Represented for Discussion only)

CP.* Systems Design and Instrumentation of WTR In-Pile Test Loops. *M. A. Vogel*, Westinghouse Electric Corp.

CP.* Instrumentation and Control System for the WTR Critical Experiments. *F. L. Kelly*, Westinghouse Electric Corp.

Management

CP.* Work Measurement for the Engineer and for Management. *J. F. McQuillin*, West Penn Power Co.

CP.* Work Simplification in a Public Utility. *A. Antonette*, Detroit Edison Co.

Research

CP58-1145. Managing Research Laboratory Finances. *T. M. Linville, C. S. Fan Wormer*, General Electric Co.

58-1153. Electrical Insulation Research in a Power Utility—A Program for Profit. *A. W. W. Cameron*, The Hydro-Electric Power Commission of Ontario.

CP58-1242. Two Examples of Industrial Research in France Relating to the Transmission of Electrical Energy. *F. M. Cahen, R. A. Tellier*, Electricite de France.

Mining Industry

CP.* The Above-Ground Substation and Underground Portable Switchhouse for A-C Mining. *D. E. Hamilton*, General Electric Co.

CP.* The Underground Mine Power Center for A-C Mining. *V. H. Youel*, Westinghouse Electric Corp.

CP.* Underground Cable Choice and Installation for A-C Mining. *T. R. Weichel*, Okonite Co.

CP.* Safety Distribution Centers for A-C Mining. *G. P. Benish, Mining.*

Communication Switching Systems

58-1243. A New Small Crossbar Telephone System for Private Branch Exchanges. *H. H. Abbott*, Bell Telephone Labs, Inc.

CP58-1355 Restricters for Direct Distance Dialing. *C. W. Freeman*, North Electric Co.

CP58-1244. Mobile Telephone Switching Equipment. *L. F. Bernhard*, Illinois Bell Telephone Co; *E. N. Duff*, Michigan Bell Telephone Co.

58-1245. Optimal Utilization and Extension of Interoffice Trunking Facilities. *R. E. Kalaba, M. L. Juncosa*, The Rand Corp. (Re-presented for Discussion only)

58-1246. Mechanization of Toll Switching at Providence, Rhode Island. *C. W. Anderson and H. N. Thornton*, New England Telephone & Telegraph Co. (Represented for Discussion only)

Switching Surges

CP.* Switching Surges on High-Voltage Systems—Progress Report. AIEE Working Group on Switching Surges.

CP58-1247. Switching Surge Voltages due to the Interruption of Transformer Magnetizing Current. *A. K. Amchin*, American Electric Power Service Corp.; R. T. *Curto*, The Detroit Edison Co.

58-1185. Overvoltage Following Secondary Switching of Transformers Connected to High Voltage Lines. *L. O. Barthold, I. B. Johnson, A. J. Schultz*, General Electric Co.

58-1216. Transmission Line Switching Surges as Modified by Transformer Impedances and Arrester Operation. *D. F. Shankle, E. R. Taylor, Jr.*, Westinghouse Electric Co.

58-1178. Magnification of Switching Surges. *A. J. Schultz, I. B. Johnson, N. R. Schultz*, General Electric Co.

The Young Engineers in the Power Industry

CP58-1146. The Young Electrical Engineer in a Small Public Utility Company. *H. W. Evirs, Jr.*, Fitchburg Gas and Electric Co.

CP58-1147. The Young Electrical Engineer with a Consulting Engineering Firm. *J. C. Hitt*, Jackson and Moreland, Inc.

CP58-1148. The Electrical Engineer in Power Equipment Design. *E. S. Coleman*, Westinghouse Electric Corp.

CP58-1149. The Young Electrical Engineer in a Large Public Utility Co. *C. F. Paulus*, Cleveland Electric Illuminating Co., *R. L. Webb*, Consolidated Edison Co. of N. Y., Inc.

Feedback Control Systems for Metal Rolling and Processing

CP.* Feedback Control Systems in the Metal Rolling and Processing Industries. *A. W. Smith, J. W. Cook*, Westinghouse Electric Corp.

CP* The Use of Frequency Response Tests in the Analysis of a Foil Mill Automatic Gauge Control. *R. M. Sills*, General Electric Co.

CP.* Simulation of Steel Mill Control Systems. *R. A. Phillips*, General Electric Co.

CP.* Hot Strip Mill Gage Control. *O. C. Gochenour*, Jones & Laughlin Steel Corp.

Emergency Operation of Industrial Plant Power Systems

CP53-1368. The Development of Reliable Electrical Systems in Petroleum Refineries. *J. C. Howard*, Standard Oil Co. of Indiana.

CP.* Role of Modern Switchgear in Preventing and Coping with Operating Emergencies. *W. P. Burt, W. A. Fleshli*, General Electric Co.

CP58-1250. A Power System Designed for Reliability and Emergency Operation. *R. Loewe*, Argonne National Lab.

58-1188. High Capacity Current Limiting Fuses Today. *E. M. Fitzgerald, V. N. Stewart*, General Electric Co. (Re-presented for Discussion only)

Semiconductor Switching Devices—I

58-1249. Theory of Transient Build-up in Avalanche Transistors. *W. Shockley, J. Gibbons*, Shockley Semiconductor Labs.

CP.* P-N-P-N Switches. *J. M. Goldey*, Bell Telephone Labs., Inc.

CP.* Germanium P-N-P-N Switches. *I. A. Lesk*, General Electric Co.

CP58-1223. High Gain Static A-C Switch. *E. A. Petrocelli*, Westinghouse Electric Corp.

CP58-1248. A Silicon Controlled Rectifier—Its Characteristics and Ratings—*I. D. Bisson, R. F. Dyer*, General Electric Co.

Mining Industry

CP.* A-C Powered Mining Machines. *R. Holcombe*, Jeffrey Mfg. Co.; *J. B. Wren*, Westinghouse Electric Corp.

CP.* An A-C Powered Shuttle Car. *A. L. Lee*, Consolidation Coal Co.

CP58-1251. Multimotor A-C Powered Direct Drive Shuttle Car. *J. Pokelsek*, The Reliance Electric & Engineering Co.; *R. D. Greer*, Joy Mfg. Co.

58-1210. Trends in Automatic Hoist Controls. *G. L. Tiley, E. Zucker*, Canadian Westinghouse Co., Ltd.

Safety

CP58-1364. Some Aspects of Grounding, Insulating, and Bonding in the Problem of Shock Hazard. *J. D. Hays*, Bell Telephone Labs., Inc.

CP.* Hazard Control in Electrical Testing. *J. V. Grimaldi*, General Electric Co.

CP58-1252. An Objective Look at Electrode or Grounding Voltages for Safety on Industrial Machine Controls. *H. E. Dow, R. W. Bradley*, United Shoe Machinery Corp.

CP58-1209. Higher Residential Voltages—Safety Considerations. *H. H. Walson*, General Electric Co.

Transmission and Distribution

58-1255. Bibliography on Extrahigh-Voltage Systems. *P. A. Abetti* General Electric Co.

CP58-1256. Application of Electronic Computers to Structural Design of Transmission Towers. *A. M. Lount*, A. M. Lount and Associates.

CP58-1254. First Report on Corrosion Tests of New Steel Wire with Thick Aluminum Covering. *J. G. Cavanagh*, Copperweld Steel Co.

58-403. Lightning Current Distribution in Towers and Ground Wires. *I. B. Johnson, A. J. Schultz*, General Electric Co.; *W. S. Price*, American Electric Power Service Corp. (Re-presented for Discussion only)

58-1253. Magnetic Fields Around a Transmission Line Tower. *J. G. Anderson, J. H. Hagenguth*, General Electric Co. (Re-presented for Discussion only)

Theory and Practice of Reactor Control

CP.* A Digital Nuclear Reactor Control

System. *E. P. Gyftopoulos, P. M. Goble,* Massachusetts Institute of Technology.

CP.* The Effect of Feedwater Control on a Pressurized Reactor. *E. F. Borner,* General Electric Co.

CP.* Automatic Control of Boiling Water Reactors. *M. A. Head,* General Electric Co.

CP.* Variable Moderator Level Control of Boiling Water Reactor. *S. R. Nixon,* American Standard Corp.

CP.* Stability Study of Enrico Fermi Power Plant. *R. N. Albrecht,* University of Michigan.

Characteristics of Loads

58-1258. Characteristics of an Electric Resistance Furnace Load. *W. A. Stelzer,* The Dow Chemical Co.

58-1259. Load Characteristics of a Submerged Arc Silicon Smelting Furnace. *G. Grant III,* Dow-Corning Co.

CP58-1200. Characteristics of Electrical Loads in a Cement Plant. *L. C. Pringle,* Hercules Cement Co.

Semiconductor Switching Devices—II

CP.* High-Current Trinistors. *F. S. Stein, E. W Torok,* Westinghouse Electric Corp.

CP.* A Silicon High-Current Transistor Switch of Low Saturation Resistance. *D. Navon, P. DeBeurs,* Transitron Electronic Corp.

58-1260. Silicon Controlled Rectifiers from Oxide-Masked Diffused Structures. *R. W. Aldrich, N. Holonyak, Jr.,* General Electric Co.

58-1206. Linear Power Amplifiers Using Dynistors or Trinistors. *F. J. Hierholzer, Jr.,* Westinghouse Electric Corp.

CP.* A Controlled Rectifier in Power Control Applications. *W. D. Cockrell, C. S. Walker, J. D. Harnden, Jr.,* General Electric Co.

58-1234. The Controlled Rectifier—Key to the Continuing Control Renaissance. *J. D. Harnden, Jr.,* General Electric Co. (Re-presented for Discussion only)

Electric Systems for Metal Rolling and Processing

CP.* An Automatic Numerical Data Logging System for Tinplate Lines. *G. E. Terwilliger,* General Electric Co.

CP.* A New System for Fully Card Programmed Blooming Slabbing Mill Operation. *E. F. Boening,* Allis-Chalmers Mfg. Co.

CP.* Industrial Control Designs for a Changing Technology. *P. A. Travisano,* General Electric Co.

58-903. An Automatic Gauge Controller for a 56-Inch Reversing Steel Mill. *R. L. Duke, L. R. Hulls,* Canadian Westinghouse Co. Ltd. (Re-presented for Discussion only)

Computer Application in Power Systems

CP58-1261. Machine Printing of Flow Diagrams for Digital Load-Flow Solutions. *J. L. Bloodworth,* Bonneville Power Adm.

58-1262. Digital Program for the Economic Selection of Generating Capacity Additions. *A. Cohen,* The Service Bureau Corp.; *L. E. Jensen,* Illinois Power Co.

58-1171. A Primer on Loss Formulas. *D. C. Harker,* Commonwealth Associates, Inc.

CP58-1217. Transmission and Distribution Interruption Records by Mechanical Accounting Methods. *J. R. Gummersall, J. J. Russell,* Long Island Lighting Co.

58-1189. Some Applications of a New Approach to Loss Minimization in Electrical Utility Systems. *T. W. Sze, J. R. Garnett, J. F. Calvert,* University of Pittsburgh. (Re-presented for Discussion only)

The Motivation Multiplier in Electrical Engineering Education

CP.* The Profile of an Engineer. *G. D. Lobingier,* Westinghouse Electric Corp.

CP.* Techniques for Motivating Students. *S. R. Warren, Jr.* Univ. of Pennsylvania; *B. R. Teare,* Carnegie Institute of Technology.

CP.* Motivation through Challenge. *W. C. Johnson, P. R. Clement,* Princeton University.

CP.* Opportunity and Responsibility as Motivators for Engineers. *W. G. Amey,* Leeds & Northrup Co.

CP.* 1,200 Case Studies of Engineering Motivation. *G. E. Moore,* Westinghouse Electric Corp.

Communication Theory

CP58-1263. Simplified Analysis of Digital Error Correction Techniques. *E. E. Moore,* Radio Corp. of America.

CP.* A Mechanized Radar Observer, *G. P. Dineen,* Massachusetts Institute of Technology.

CP58-1264. Utility Value Concepts in the Analysis of Communication Systems. *L. S. Schwartz,* New York University.

CP.* Asynchronous Multiplexing. *J. E. Taylor,* General Electric Co.

CP.* Imaginary Axis Translation of Transfer Functions. *J. L. Ryerson,* Griffiss Air Force Base.

58-1157. Recent Progress in Applying Information Theory to Digital Transmission Systems. *R. Filipowsky,* Westinghouse Electric Corp. (Re-presented for Discussion only)

58-1233. Binary Communication Feedback Systems. *B. Harris, A. Hauptschein, K. C. Morgan, L. S. Schwartz,* New York University (Re-presented for Discussion only)

Drive Systems for Reversing Hot Mills

CP.* The Electrical Characteristics of a Universal Slabbing Mill. *C. J. Bevan,* Bethlehem Steel Co.

CP.* Programming of Reversing Hot Mills. *W. M. Brittain, E. H. Browning,* Westinghouse Electric Corp.

CP.* Industrial Control Systems for Reversing Hot Mill Drives. *G. A. Kaufman, J. T. Bradford,* General Electric Co.

58-1265. Motor Field Control of Large D-C Reversing Mill Motors. *L. R. Hulls, G. H. Samuel,* Canadian Westinghouse Co., Ltd. (Re-presented for Discussion only)

Rotating Machinery and Relays

58-1190. Protection of Pilot-Wire Relay Circuits. AIEE Subcommittee on Pilot Wires. *J. L. Blackburn,* Chairman.

58-1224. Operation of Apparatus Protective Relaying at Reduced Frequencies. AIEE Subcommittee on Generator Protection. Presented by *H. T. Seeley.*

58-1179. How To Specify the Noise Rating of Large Electric Rotating Machines. *M. E. Talaat,* Elliott Co.

58-1218. Proposed Test Procedure for Noise Measurements on Rotating Electric Machinery. A Committee Report, *C. G. Veinott,* Chairman.

Automation of Classification Yards

CP58-1213. Modern Railroad Freight Classification Yards Operation and Maintenance Considerations. *H. A. Scott,* New York Central System.

58-1266. An Automatic Speed Control System for a Gravity Freight Classification Yard. *R. J. Berti,* Union Pacific Railroad Co.; *T. J. Dosch,* Reeves Instrument Corp.

CP58-1230. A Method for Automatic Control of Car Retarders. *H. C. Kendall, J. H. Auer, Jr.,* General Railway Signal Co.

Feedback Control Systems—I

58-1271. Quasi-Optimization of Relay Servos by Use of Stored Energy for Braking. *C. McDonald, G. J. Thaler,* U. S. Naval Post-graduate School.

58-1191. A Dual-Mode Servomechanism Utilizing Saturation Switching. *H. R. Weed, F. C. Weimer,* The Ohio State University. (Re-presented for Discussion only)

58-1268. The Effect of Speed-Dependent Friction and Backlash on the Stability of Automatic Control Systems. *E. A. Freeman,* English Electric Co. Ltd., formerly of Kings College.

58-1192. Optimum Response of Discontinuous Feedback Control Systems. *F. W. Nesline, Jr.,* Massachusetts Institute of Technology. (Re-presented for Discussion only)

58-1267. Two Theorems on the Number of Real Roots of the Characteristic Equation of Any Stable Linear Physical System *J. F. Koenig,* The George Washington University.

58-1321. System Considerations in Computer Control of Semicontinuous Chemical Process. *T. M. Stout,* Ramo-Wooldridge Corp. (Re-presented for Discussion only)

CP58-1270. Classified Bibliography on Feedback Control Systems Part II: Root-Locus and Associated Procedures. *T. J. Higgins,* University of Wisconsin.

58-1327. Instability in a Nonlinear Conditionally Stable System Subjected to a Sinusoidal Input. *J. L. Douce, R. E. King,* Queen's University of Belfast.

Nuclear Power Plants—I

58-1199. Electrical and Control Features of the Shippingport Atomic Power Station *H. G. Frus, H. A. Thompson, H. A. Van Wassen, E. J. Woolever,* Duquesne Light Co.

CP.* Operating Experience on Vallecitos Boiling Water Reactor. *L. Kornblith,* General Electric Co., *W. Raymond,* Pacific Gas & Electric Co.

CP58-1273. Performance on the Sodium Reactor Experiment. *J. E. Owens, W. T. Morgan, L. E. Glasgow,* North American Aviation, Inc.

CP.* Design Problems and Operating Experience on the APPR-1. *K. Kasschau,* Alco Products, Inc.

58-1272. Organic Moderated Reactors for Central Station Power. *W. E. Parkins, E. F. Weismer,* North American Aviation, Inc.

Transmission and Distribution

58-1214. Unbalanced Loading of 3-Phase Transformer Banks—III Effect of Transformer Impedance. *S. W. Anderson,* Middle West Service Co.

58-1172. Motor Starting Lamp Flicker on Open Delta Transformer Banks. *J. C. Neupauer,* Westinghouse Electric Corp.; *C. L. Smith, Jr.* Light, Water and Sewerage Dept., Griffin, Georgia.

CP58-1274. Tests on Protective Gaps for Distribution Series Capacitors. *H. E. Weaver,* Commonwealth Edison Co.; *N. M. Neagle,* General Electric Co.

58-1184. Report of a Survey on the Connection of Shunt Capacitor Banks, AIEE Capacitor Subcommittee of T. & D. Committee, *B. H. Schultz,* Chairman.

58-258. Higher Secondary Voltage for Residential Service. *A. S. Anderson, C. Hutchinson, S. J. Pearson,* Ebasco Services, Inc. (Re-presented for Discussion only)

Electronic Circuits—I

58-1326. The Diode Reactance Modulator. *G. F. Montgomery,* National Bureau of Standards.

58-1238. A Stable, Direct Coupled, Transistor Servo Preamplifier. *A. N. DeSautels,* Minneapolis-Honeywell Regulator Co.

58-1237. Performance of Class B Audio Amplifiers with Random Noise Signals. *T. Usher, Jr.,* Yale University.

58-1275. An Analog Frequency Measuring Circuit Accurate to 0.1%. *J. Mitchell,* Link Aviation, Inc. (Re-presented for Discussion only)

58-1276. Transistor Phase Locked Oscillators *K. A. Edwards, O. Golubjatnikov,* General Electric Co.; *D. J. Brady,* United Engineers, Inc. (Re-presented for Discussion only)

Rotating Machinery

CP.* Measurement of Rapidly Changing Temperatures. *J. E. Shea,* Underwriters Labs.

CP58-1360. Application Problems in the Measurement of Motor Winding Temperatures. *C. E. Green, T. Spink, Jr., D. Vandeventer,* Leeds & Northrup Co.

PREPRINT PRICES

40¢ to Members
80¢ to Nonmembers

MINIMUM ORDER by mail $1.20 unless accompanied by remittance or coupons. All nonmember orders *must* be accompanied by remittance.

COUPON BOOKS in ten-dollar denominations may be purchased.

NUMBERED PAPERS only are available.

SEND ORDER and remittance to:
AIEE Order Department
33 West 39th Street,
New York 18, N.Y.

CP.* Start Winding Temperature Measurement of Fractional Horsepower Motors. *R. E. Seely*, General Electric Co.

CP.* Temperature Measurement of Fractional Horsepower Motors. *W. R. VanDyke*, Westinghouse Electric Corp.

CP58-1278. Temperature Measurement of Motor Windings on Stalled Rotor. *V. G. Vaughan, A. P. White*, Metals & Control Corp.

Land Transportation

58-1212. Freight Car Tractive Resistance Measurements by Doppler Radar. *R. D. Campbell*, Westinghouse Air Brake Co.

CP58-1207. Car Accelerator for Railroad Classification Yards. *J. D. Hughson*, General Railway Signal Co.

58-1159. A Novel Generating System for Railroad Cabooses. *L. B. Haddad, R. A. Vercella, D. W. Brown*, Safety Industries, Inc.

Relays and Transmission and Distribution

58-1183. Improved Protection of 4-Kv Feeders on the Baltimore Gas & Electric Co. System. *W. W. Ward, Jr.*, Baltimore Gas & Electric Co.

58-1222. Distribution Circuit Protection American Electric Power *W. H. Johnson, T. J. Meier*, American Electric Power Service Corp.

58-1229. Distribution Protection as Used on the Portland General Electric Co. System, Portland, Oregon. *M. A. Bostwick*, Portland General Electric Co.

58-1196. Distribution Circuit Protection. *E. L. Guenzel, W. T. Morris*, Texas Electric Service Co.

58-1322. High-Speed Magnetic Air Breaker for Distribution Circuits. *H. P. Sleeper*, Public Service Electric & Gas Co.; *J. D. Findley*, Westinghouse Electric Corp. (Re-presented for Discussion only)

Insulated Conductors

58-1175. Grounding and Cathodic Protection of Pipes for Pipe-Type Feeders. *F. E. Kulman* Consolidated Edison Co. of N. Y., Inc.

CP.* The St. Lawrence River High-Voltage Submarine Cable Crossing Part III—Installation. *D. M. Farnham, S. H. Cunha*, Quebec Hydro Electric Commission; *G. B. Shanklin*, Schenectady, N. Y.; *H. D. Short*, Canada Wire and Cable Co., Ltd.

CP.* The St. Lawrence River High-Voltage Submarine Cable Crossing Part IV—Final Tests and Field Data. *D. M. Farnham, S. H. Cunha*, Quebec Hydro Electric Commission; *G. B. Shanklin*, Schenectady, N. Y.; and *H. D. Short*, Canada Wire and Cable Co., Ltd.

Power System Communications

58-1228. Experiences with Broad-Band Carrier Coupling. *H. I. Dobson*, Tennessee Valley Authority.

CP.* TVA Power System Communication Planning. *L. F. Kennedy*, General Electric Co.

Electronic Circuits—II

58-1168. The Ferroresonant Circuit. *G. E. Kelly*, Prairie View Agricultural and Mechanical College.

58-1277. Design Criteria for Low-Level Second-Harmonic Magnetic Modulators. *E. J. Kletsky*, Syracuse University. (Represented for Discussion only)

58-1174. Linearization of Deadspace. *S. Jones*, Hughes Aircraft Co.

Radio Communication Systems

58-1236. Radio Attenuation at 11 Kmc and Some Implications Affecting Relay System Engineering. *S. D. Hathaway, H. W. Evans*, Bell Telephone Labs., Inc.

58-1227. The Expansion of the Pacific Coast Microwave Network. *R. G. Kuck*, Pacific Telephone and Telegraph Co.

CP.* A UHF Exciter for AM, FM, and SSB. *S. Kitces*, Westinghouse Electric Corp.

58-989. Systems Engineering of Personal Radio Signaling Systems. *W. Strack*, Bell Telephone Labs., (Re-presented for Discussion only)

Rotating Machinery

58-1180. A General Method for Slot Constant Calculation. *K. J. Waldschmidt*, A. O. Smith Corp.

58-1158. Polyphase Induction Motors with Unbalanced Rotor Connections. *B. N. Garudachar, N. L. Schmitz*, University of Wisconsin.

58-1280. Results of Motorette Evaluation of Insulation Systems. *H. P. Boettcher*, A. O. Smith Corp.

CP58-1290. Effect of Air-Gap Eccentricity on Motor Sound Level. *J. J. Courtin*, Westinghouse Electric Corp.

58-849. Sources of Electromagnetic Vibration in Single-Phase Induction Motors. *L. W. Magyar*, General Motors Corp. (Re-presented for Discussion only)

Power System Operation—Dispatching and Personnel

CP58-1281. Daily Dispatching and Scheduling of Kilovars. *J. O. Swanson, W. R. Bosshart*, Bonneville Power Administration.

CP58-1282. New Load Dispatching Center for Philadelphia Electric Company System. *W. H. Johnson*, Philadelphia Electric Co.

CP58-1283. The Selection and Training of Operating Personnel. *M. J. Thrasher*, Long Island Lighting Co.

CP58-1211. Selection and Training of Operating Personnel for a Nuclear Power Station. *E. J. Woolever*, Duquesne Light Co.

Industrial Control

58-1166. The Application of Shift Register Techniques to Materials Handling. *H. C. Diener, Jr.*, Westinghouse Electric Corp.

CP58-1284. Logic Design Techniques of Static Switching Control for Transfer Machines. *J. W. Stuart, R. A. Manning*, Westinghouse Electric Corp.

58-1285. Static Control in Automatic Warehousing. *L. L. Bosch, A. J. Fanthrop*, Bosch & LaTour; *J. W. Stuart*, Westinghouse Electric Corp.

58-1176. Elements of Reactor Controlled Reversible Induction Motor Drives. *W. Leonhard*, Westinghouse Electric Corp.

CP.* Transistorized Regulator for Battery Charging. *E. E. Moyer*, Acme Electric Corp.

Substations

58-1197. Design and Analysis of an Unplated High-Pressure Limited Area Bolted Electric Joint Including a Method of of Calculating the Various Components of Joint Resistance. *R. K. Allen*, General Electric Co.

CP58-1286. Aluminum Angle Substation Bus Conductor. *L. G. Weber*, Northern States Power Co.; *H. Fossum*, Pioneer Service & Engineering Co.

CP.* Cast Aluminum Alloy for Power Connectors. *M. Brenner*, Penn-Union Electric Corp.

CP.* Fasteners for Electrical Connections on Aluminum Bus Conductors. *D. H. Sandell, J. W. Atman*, Aluminum Co. of America.

CP58-1288. Preparation of Aluminum Conductors for Stable Electrical Connections. *M. R. Monashkin*, Burndy Corp.

Nuclear Power Plants—II

CP58-1289. Electrical Features of Yankee Atomic Electric Plant. *E. T. Witt*, Stone & Webster Engr. Corp.; *C. F. Obermesser*, Westinghouse Electric Corp.; *R. E. Minkwitz*, New England Power Service Co.

58-1194. Electrical Features of Indian Point Nuclear Electric Generating Station. *T. D. Reimers*, Consolidated Edison Co. of New York, Inc.

CP58-1219. A Look at the Electrical Features—Dresden Nuclear Power Station. *W. J. Shewski*, Commonwealth Edison Co.

CP.* A Single Region Slurry Homogeneous Reactor—Pennsylvania Advanced Reactor Project—Design and Maintenance. *S. C. Townsend*, Penna. Power & Light Co.; *W. E. Johnson, D. H. Fax*, Westinghouse Electric Corp.

Magnetic Amplifiers

58-1177. Reversible Polarity D-C Power Amplifier Using Magnetic Amplifier Controlled Switched Transistors. *N. L. Schmitz, T. Bernstein*, University of Wisconsin.

58-1328. 1957 Magnetic Amplifier Bibliography. AIEE Applications Subcommittee Report—*E. J. Alexander*, Chairman Working Group.

58-1215. Behavior of the Ferroresonant Series Circuit Containing a Square Loop Reactor. *R. H. Dennard*, International Business Machines Corp.

58-1193. Volt-Second Transfer Efficiency in Fast Response Magnetic Amplifiers—Part I—N^2R and Control. *T. J. Pula*, Westinghouse Electric Corp. (Re-presented for Discussion only)

58-173. Volt-Second Transfer Efficiency in Fast Response Magnetic Amplifiers—Part II—N^2R as a Design Parameter. *T. J. Pula, G. E. Lynn, J. F. Ringelman*, Westinghouse Electric Corp. (Re-presented for Discussion only)

58-1162. A Magnetic-Amplifier Commutating and Pulse-Width Encoding Circuit. *W. H. Lucke*, U. S. Naval Research Lab.

58-1231. On Feedback in Magnetic Amplifiers—Part I—Single Feedbacks. *L. A. Finzi*, Carnegie Institute of Technology, *J. J. Suozzi*, Bell Telephone Labs., Inc.

CP58-1232. On Feedback in Magnetic Amplifiers—Part II—Combined Magnetic and Electric Feedbacks. *L. A. Finzi*, Carnegie Institute of Technology; *J. J. Suozzi*, Bell Telephone Labs, Inc.

Computers in Control Systems

CP58-1182. Progress in Sampled-Data Systems. *E. I. Jury*, University of California.

CP.* Survey of Sampled Data Systems Analysis. *J. F. Howell*, Packard Bell Computer Corp.

58-1291. A General Approach for Obtaining Transient Response by the Use of a Digital Computer. *P. E. Lego*, Westinghouse Electric Corp.; *T. W. Sze*, University of Pittsburgh.

58-1198. The Operational Amplifier as a Laboratory Tool. *P. E. Pfeifer*, The Rice Institute.

Electrical Insulation

CP.* Three Decades of Progress in Electrical Insulation. *L. J. Berberich*, Westinghouse International Co.

58-1208. The Present Status and Anticipated Progress in the Field of Insulating Materials. *T. D. Callinan*, International Business Machines Corp.

CP.* 20 Years of Progress in Silicone Insulation. *J. F. Dexter*, Dow Corning Corp.

CP.* Applications and Research Progress in Gaseous Dielectrics. *T. W. Liao, H. G.*

Pfeiffer, R. E. Plump, General Electric Co.

Radio Communication Systems

58-1292. Dial Telephone Service for Smith Island—An Isolated Community in the Chesapeake Bay. *M. E. Littleton*. The Chesapeake and Potomac Telephone Co. of Maryland.

CP.* ABC's of PCM. *J. Cohn*, Motorola, Inc.

58-1293. Public Air-Ground Telephone Service Trial. *L. M. Augustus*, Michigan Bell Telephone Co.

Rotating Machinery

CP58-1334. The Life of Class A Random-Wound Motor Insulation (A Report). *P. L. Alger*, General Electric Co.

CP.* Insulation System Development Aided by Motorette Test. *G. P. Gibson, P. G. Lucey*, Westinghouse Electric Corp.

58-1279. Iron Loss Calculations on Fractional Horsepower Induction Motors. *P. H. Trickey*, Wright Machinery Co.

CP58-1318. Computing Iron Losses in Fractional Horsepower Induction Motor Design. *C. E. Linkous*, General Electric Co.

58-1221. Influence of Higher Operating Temperatures on Motor Design. *R. F. Woll*, Westinghouse Electric Corp.

Power System Planning and Operating

CP58-1294. System Stability and Related Problems in the West Central United States. *H. D. Hunkins*, Bureau of Reclamation.

58-1295. Rural Distribution Planning. *E. H. Breckenfelder, C. M. Stanley*, Stanley Engineering Co.

58-1195. Forecasting Procedures Advance Effective Water Routings on the U.S. Columbia River Hydroelectric System. *H. M. McIntyre, M. S. Sachs*, Boneville Power Administration.

58-1156. More Angles of Phase Shift Added to Previously Known Ice Melting Methods. *I. R. Ekstrom*, Commonwealth Edison Co.

58-1163. An Automatic Dispatching System. *M. J. Brown*, Westinghouse Electric Corp.

Substations

CP58-1287. Evaluation of Two Basic Shapes of Conductor Grooves for Aluminum Power Connectors. *W. Frank, M. Monashkin*, Burndy Corp.

58-1296. Supervisory Control for Air Force Missile Test Center. *C. L. Cadwell*, Westinghouse Electric Corp.

CP58-1297. Application of Synchronizing Devices to Frequency Changers. *R. E. Stillwagon, S. D. Silliman*, Westinghouse Electric Corp.

CP58-1298. A Modern Current Regulator for D-C Machines. *R. A. Geiselman, G. W. Champney, J. F. Reuther*, Westinghouse Electric Corp.

Nuclear Power Plants—III

58-531. Electrical Engineering Aspects of the Enrico Fermi Atomic Power Plant. *R. H. Logue*, Power Reactor Development Co. (Re-presented for Discussion only)

CP.* Horizontal Pressure Tube Nuclear Reactor—Canadian Approach to Minimum Fuel Cost Using Natural Uranium. *F. F. Mason, S. M. Jones*, Canadian Westinghouse Co., Ltd.

CP58-1300. Training Simulator for Nuclear Power Plant Reactor Operators. *N. E. Bush*, Westinghouse Electric Corp.

Feedback Control Systems—II

57-946. Differential Analyzer Aids Design of Electric Utility Automatic Dispatching System. *L. K. Kirchmayer*, General Electric Co. (Re-presented for Discussion only)

58-1301. Positive Feedback Phase Space Trajectories and Application to Servo Systems. *Z. H. Meiksin*, University of Pittsburgh.

CP58-1302. Digital Computer Study of a Third Order Nonlinear Servomechanism. *Y. K. Ku, K. Fukunaga*, University of Pennsylvania.

58-1161. General Synthesis Procedure for Computer Control of Single and Multiloop Linear Systems. *R. E. Kalman*, International Business Machines, Inc.; *J. E. Bertram*, Columbia University. (Re-presented for Discussion only)

58-1303. Closed-Loop Analysis of Sampled Data Systems with Appreciable Pulse Width. *G. J. Murphy, H. B. Kennedy*, Northwestern University.

58-1324. Analog Computer Study of Sampled-Data Systems. *H. Chestnut, A. Dabul, D. W. Leiby*, General Electric Co. (Re-presented for Discussion only)

CP58-1269. Classified Bibliography on Feedback Control Systems—Part I: Sampled-Data Systems. *T. J. Higgins*, University of Wisconsin; *R. W. Greer*, North American Aviation Corp.

Automatic Programming of Digital Computers for Engineering and Data Processing

CP.* Fortran—A Close Look at an Automatic Coding System. *J. T. Ahlin, W. P. Heising*, International Business Machines Corp.

CP.* The Use of Automatic Programming Techniques for Solving Engineering Problems. *N. Chackan, T. V. Martin, J. T. Carleton*, Westinghouse Electric Corp.

CP.* Automatic Programming for Data-Processing Problems. *G. M. Hopper*, Sperry Rand Corp.

CP.* A Specialized Automatic Programming System for the Air Materiel Command. *Col. E. R. Miller*, Dayton Air Force Depot.

Rotating Machinery

CP58-1305. Pioneering Insulation Evaluation. *C. M. Magers, J. S. Askey*, Elliott Co.

CP.* Accelerated Voltage Endurance Tests. *R. G. Rhudy, H. E. Mazanek*, General Electric Co.

58-1304. A Technique of Measuring the Amplitude and Harmonic Content of Surge Voltages in Machine Windings during Switching. *F. A. Scheda*, Westinghouse Electric Corp.

58-1320. Torque and Speed Control of Induction Motors Using Saturable Reactors. *J. F. Szabyla*, The University of British Columbia.

Transformers

58-1306. Temperature Rise Tests on Ventilated Dry-Type Transformers. *M. F. Beavers, L. C. Whitman*, General Electric Co.

58-1165. The Surge Performance of Transformers and Rotating Machines—Survey and Classifications of Published Data. *P. A. Abetti*, General Electric Co.

58-1164. Bibliography on the Surge Performance of Transformers and Rotating Machines. *P. A. Abetti*, General Electric Co.

CP.* Inner-Cooled Large Power Transformers. *W. D. Albright, H. R. Moore*, Westinghouse Electric Corp.

Switchgear

58-1220. A Study of the Dynamic Response of Arcs in Various Gases. *K. H. Yoon, H. E. Spindle*, Westinghouse Electric Corp.

58-1155. An Approach to Mathematical Analysis of A-C Arc Extinction in Circuit Breakers. *T. E. Browne, Jr.*, Westinghouse Electric Corp.

58-943. The Effect of Linkage Flexibility of Dynamics of High Capacity Outdoor Circuit Breakers. *P. Barkan, E. J. Tuohy*, General Electric Co.

58-1225. Field Testing of a 69-Kv Oil Circuit Breaker by the Southern California Edison Co. *P. C. Edwards*, Federal Pacific Electric Co.; *P. Q. Nelson*, Southern California Edison Co.

58-1307. An Improved Line of Frame-Mounted Outdoor Oil Circuit Breakers for Intermediate Voltages. *E. E. Briggs, R. D. Hambrick*, Federal Pacific Electric Co.

Lightning Protection of Equipment

58-1226. Application of Arresters for Complete Lightning Protection of Substations. *J. M. Clayton, R. W. Powell*, Westinghouse Electric Corp.

58-524. Overvoltage Protection and Maintenance Testing of A-C Rotating Machines. *H. R. Armstrong, J. E. Mulavey*, The Detroit Edison Co.

58-1170. Lightning Protective Requirements of

Planning for Joint District Meeting

PLANNING a joint meeting for the AIEE Southeast District No. 4 and South Central District No. 13, to be held in Atlanta, Ga., April 7-10, 1959, are: (seated, left to right) J. W. Davis, Mrs. J. W. Davis, R. G. Elliott, W. S. Brown, C. L. Emerson, (standing, left to right) E. G. Riley, J. F. Willett, J. C. Howell, J. D. Howard, David Bea, W. J. McKune, and J. A. Busha. Other general committee members not shown are D. C. Kyker, Jr., T. J. Allen, and Prof. E. R. Weston.

Generators Connected to the System through Y-Grounded–Delta Transformers. *J. K. Dillard, A. R. Hileman,* Westinghouse Electric Corp.

58-1160. Surge Transfer through 3-Phase Transformers. *A. R. Hileman,* Westinghouse Electric Corp.

58-1203. Lightning Arrestor Testing, a Proposal for a Revision in the Standards. *E. Beck,* Westinghouse Electric Corp.

Training in Communications

CP58-1235. Industry Schools Its Engineers. *C. E. Waldner,* New York Telephone Co.

58-1152. A New Approach to Training Telephone Engineers. *W. C. Burnett,* Southern Bell Telephone and Telegraph Co.; *L. C. Adams,* Clemson College.

CP58-1324. Telephone Engineering Management Conference. *P. H. Henson,* Lincoln Telephone and Telegraph Co.

CP.* The Evaluation of Engineering Training in Industry. *A. L. Charney,* Bell Telephone Co. of Pennsylvania.

Power Systems Operations—Maintenance Costs

58-1201. Time-Error Control for Interconnected Synchronous Electric Power Systems. *D. Broadbent,* The New South Wales University of Technology.

CP58-1308. Fundamental Concepts of Incremental Maintenance Costs as Used by Ohio Edison Co. *D. B. Zelenka, R. H. Travers,* Ohio Edison Co.

CP58-1309. Determination of Output Maintenance Costs on the West Penn Electric System. *R. L. Ballentine,* The Potomac Edison Co.; *R. F. Crim, H. T. McCarthy,* West Penn Power Co.; *T. A. Lake, W. S. Schmidt,* Monongahela Power Co.

58-1187. Application of Digital Computer Technique for Development of the Incremental Maintenance Cost. *F. H. Light,* Philadelphia Electric Co.

CP58-1336. Preliminary Report on Survey of Maintenance Costs Applicable to Incremental Generation. *L. T. Anstine,* Baltimore Gas and Electric Co.

Rotating Machinery

CP58-1311. A Utility's Functional Evaluation Tests for High-Voltage Stator Insulation. *A. W. W. Cameron, M. Kurtz,* Hydro-Electric Power Commission of Ontario.

CP58-1310. Tests and Life Expectancy of Generator Windings. *V. S. McFarlin,* Boston Edison Co.

CP58-1312. Experience in Analysis of D-C Insulation Test for Maintenance Programming. *F. R. Schleif, L. R. Engvall,* Bureau of Reclamation.

58-1151. Development of Device To Protect Turbogenerator from Damage Because of Thrust Bearing Failure. *R. Bruce, C. A. Roberts, K. C. Byram,* Tennessee Valley Authority.

Transformers

58-1150. The Relationship between Operating Voltage and the Standard Dielectric Tests for Power and Distribution Transformers. AIEE Committee Report of Dielectric Tests Subcommittee. *H. H. Wagner,* Chairman of Working Group.

58-1169. Are Stabilizing Windings Necessary in All Y-Connected Transformers. *B. A. Cogbill,* General Electric Co.

58-1154. The Influence of Performance and Design Limits on the Design of Power Transformers by Computer. *W. G. Chambers,* Westinghouse Electric Corp.

CP58-1325. Computers Change Transformer Design Philosophy. *H. J. Weber, G. Gallousis,* Allis-Chalmers Mfg. Co.

Switchgear

58-1173. Testing Magnetic Air Circuit Breakers for 5-Cycle Performance. *J. D. Wood, W. A. Carter,* I-T-E Circuit Breaker Co.

58-1313. A New Isolated Phase Bus Design. *H. H. Rugg, P. H. Westermeyer,* Westinghouse Electric Corp.

CP.* Inspection and Maintenance of Magnetic Air Circuit Breakers and Associated Metal Clad Switchgear. *R. C. Dickinson,* Westinghouse Electric Corp.

58-1202. Selecting Damping Resistors for Vacuum Switches in Bank-to-Bank Switching. *J. Zaborsky,* Washington University; *J. W. Rittenhouse, E. L. Leuhring,* Hi Voltage Equipment Co.

CP58-1317. Recent Developments in Metal-Clad Switchgear. *J. W. McMillen,* Westinghouse Electric Corp.

Computers in Nuclear Systems

CP58-1314. Digital Calculation of Transient Performance of the Primary Coolant System in a Water Reactor. *D. G. Lewis,* General Electric Co.

CP58-1315. Computational and Experimental Techniques in Nuclear Reactor Design. *W. F. Witzig, M. R. Stuart, L. O. Herwig,* Westinghouse Electric Corp.

CP.* Present Status of Analog Representations of Nuclear Power Systems. *J. M. Gallagher,* Westinghouse Electric Corp.

CP58-1316. Engineering Description of a Water-Moderated Flexible Critical Facility Using Metal Fuel. *E. S. Lemberskv,* Westinghouse Electric Corp.

CP.* Shielding Computer Program. *J. T. Martin, J. P. Yalch,* General Electric Co.

Electrical Insulation

58-1205. Thermal Life of Enameled Magnet Wire. Electrical Insulation Committee Working Group Report.

58-1186. On the Behavior of Natural and Artificial Voids in Insulation under Internal Discharge. *S. I. Reynolds,* General Electric Co.

58-1167. New Inorganic Insulation for 500 C Electrical Equipment. *C. H. Vondracek, E. J. Croop,* Westinghouse Electric Corp.

58-1239. Electric Breakdown of Gases and Vapors of Chlorofluoro-hydrocarbons. *C. N. Works, E. W. Lindsay,* Westinghouse Electric Corp.

CP.* Factors Affecting the Electric Strength of Electronegative Gaseous Insulation. *P. Narbut, D. Berg, C. N. Works, T. W. Dakin,* Westinghouse Electric Corp.

Courtesy Ontario Hydro

ENGINEERS from the United States, Canada, and several other countries attended the AIEE Power Industry Computer Application Conference, held September 15-17, 1958, in Toronto, Ont., Canada.

Power Industry Computer Application Conference

A final registration figure of 245 was reached for the AIEE Power Industry Computer Application Conference held in Toronto, Ont., Canada, September 15-17, 1958. The Conference displayed an international aspect with three people coming from West Germany, one from Sweden, and two from the United Kingdom, as well as representatives from almost every one of the United States. There were Canadians attending from Vancouver through to the Maritimes.

The Conference was opened on Monday morning by W. R. Strike, first vice-chairman of the Hydro Electric Power Commission of Ontario, who welcomed everyone to Canada on behalf of the electrical industry. Mr. Strike emphasized the fact that it was an achievement to have machines which appeared to think as men but that we should never cause men to act and think like machines.

During the 3-day Conference, a total of 22 papers were presented, dealing with the best ways of using computers for a great many problems. Discussion also took place on problems which arise when computers are used.

Among the papers presented, two related groups evoked considerable interest and discussion. Sessions on Economic Studies of Power Systems, and Analysis of Power Systems were particularly well attended. Seven papers, which dealt with digital computer solution of power network problems under steady-state and transient conditions, were features of both sessions. According to evidence presented in these papers, the computer is definitely competitive as a complementary function to network analyzers.

The great interest in power systems applications was closely followed by the interest shown in system component design, with synchronous machines and transformers receiving particular attention and detailed treatment. That the computer is becoming vital in the design and manufacturing field was well illustrated during these other two sessions.

The dinner, held Tuesday evening during the Conference, was addressed by Prof. Marcus Long of the University of Toronto. Luncheons, held Monday and Wednesday, gave those attending an opportunity for informal discussion and exchange of ideas.

American Institute of Electrical Engineers
FOUNDED
1884
This Diploma Certifies that on
American Institute of Electrical Engineers
an organization formed for the advancement of the theory and practice of Electrical Engineering and of the allied Arts and Sciences and the maintenance of a high professional standing among its members
Witness our hand and seal at New York.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
FOUNDED
NEW YORK
1884
PRESIDENT
SECRETARY

Attractive Emplaqued Membership Certifications Available to All Grades

WHATEVER YOUR GRADE may be, these certifications of membership mounted in attractive laminated plastic plaques *(above)* will make a handsome display for home or office. Fellows, Members, and Associate Members may obtain diplomas; certificates are available to Affiliate Members. (Diplomas for Fellows and Members will carry signatures of both Secretary and President; diplomas for Associate Members and certificates for Affiliate Members will carry the signature of the Secretary.)

Price for diploma or certificate is $3.50. Those already possessing diploma or certificate (no larger than 14 by 10½ inches) may have them emplaqued for $2.50 by returning them with their orders.

All orders *must* include check or money order and mail order form *(right)* completed. Allow four to six weeks delivery.

To AIEE, 33 West 39th Street, New York 18, N.Y.

This is an order for one emplaqued diploma or certificate in the grade of

_____ which should be inscribed with my name as follows:

_____
(Name exactly as it is to appear)

My address is _____ Member No.

Remittance enclosed $ _____ (Include 50¢ extra for mailing outside U.S.A.)

TO EXPEDITE DELIVERY PLEASE COMPLETE MAILING LABEL BELOW

Name _____
(Please Print) (Membership No.)

Address _____

Postmaster: This parcel may be opened for Postal Inspection if necessary. Return postage guaranteed.

(Contents—Printed Matter) Printed in U.S.A.

Sample Contents Lists from USSR Scientific and Engineering Journals

THE FOLLOWING are sample contents lists from some of the leading Soviet scientific and engineering journals, translations of which are being made available by arrangement with the Pergamon Institute, a nonprofit organization.

For a listing and prices of the publications, available on an annual subscription basis, and ordering instructions see p. 52A of this issue of *Electrical Engineering*.

Radio Engineering & Electronics, 3, No. 5, 1958

Contents

Polekhin, A. I. Solution of electrodynamic problems by using known solutions of appropriate electrostatic and magnetostatic problems.

Potekhin, A. I.; Tartakovsky, L. B. Radiation of the Hertz dipole at the edge of an ideally conducting wedge.

Gorianov, A.S. Asymptotic solution to the problem of diffraction of a plane electromagnetic wave on a conducting cylinder.

Emelin, B. F. Waveguide equations for irregular waveguides.

Brodsky, V. B. Wave propagation in waveguides filled with medium of variable permitivity and permeability.

Katzenellenbaum, B. Z. Bent waveguides with heterogeneous filling.

Sveshnikov, A. G. Electromagnetic waves in bent tubes.

Kerzhentsev, N. P. Propagation of electromagnetic waves through bent circular waveguides.

Kovtun, A. A. Transitional processes in waveguide.

Dnestrovsky, G. N. Perturbation of electromagnetic resonator normal frequencies by ferrites.

Nikolsky, V. V. Determination of the inner field in a perturbation method by solution of a diffraction problem.

Bimonthly Publications

The bimonthly publications, *Communication and Electronic Applications and Industry* and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. Members may receive one subscription to any *one* of the bimonthlies for $2.50. The balance of the annual $5.00 subscription price will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional member subscriptions will be at the rate of $5.00. Nonmembers may subscribe on an advance annual subscription basis of $8.00 each (plus 50¢ extra for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.50 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Mitsuk, V. E.; Solntsev, G. S.; Khokhlov, M. Z.; Bulkin, P. S.; Zastenker, G. N. Electrical discharge in the air at wavelength 3.2 cm.

Khokhlov, M. Z.; Bulkin, P. S.; Mitsuk, V. E.; Tashaeva, T. F. Influence of radioactive irradiation on the development of a pulse microwave discharge.

Gertsenshtein, M. E.; Brainsky, L. M. Waveguide phase shifter with small reflection.

Brief Reports

Kuzmin, A. D. Combination of several radiators of different wave lengths in the focus of a parabolic reflector.

Current Events

Pistolkors, A. A. Paris Congress on microwave circuits and antennas.

Reviews and Bibliography

Vysokovsky, D. M.; Ortusi, J. Propagation of electromagnetic waves of high frequency (review).

Electrical Communications, 12, No. 5, 1958

Contents

Radio Day

Meshkovskii, K. A. Optimum and near-optimum binary codes.

Vysokovskii, D. M. Diffuse propagation of ultra-short waves in the troposphere with highly directional antennae.

Zyuko, A. G. Noise-resistance and efficiency of radio-telegraph communications with automatic error correction.

Paramonov, V. K.; Metrikin, A. A.; Fel'd, N. A. Measurement of small reflection factors over a wide range of frequencies using the T-bridge.

Vinogradov, D. N. Determination of the deviation from constancy of phase difference over a range of frequencies.

Kharkevich, A. A. Comparison of some possibilities for the transmission of simple pictures.

Odnol'ko, V. V.; Forman, A. S. On some researches in the field of xerography as applied to phototelegraphy.

Pripolov, E. Ya; Garyainov, S. A. The use of surface semiconducting triodes in smoothing filters.

Semenov, N. A. Conversion of a pulse signal to the form of a smooth background using a linear detector with a minimum limit.

Savvin, G. G. Basic principles of the construction of switches for electronic automatic telephone exchanges.

Braginskii, I. A.; Ivanova, O. N.; Kokhanova, Z. S. Regis'er employing surface semiconducting triodes.

Evgenii Vasil'evich Kitaev.

Radio Engineering, 13, No. 5, 1958

Contents

Development of radio communications, broadcasting, and television.

Siforov, V. I. On the capacity of communication channels with random input variations.

Gonorovskii, I. S. On the theory of high-frequency autogenerators with lagging feedback.

Kinber, B. E. On one method of successive approximations in the theory of reflectors of special shape.

Peisikhman, A. L. On the optimum pass band of a resonance system for pulses of arbitrary signal-pause ratio.

Aleksandrova, E. G. Study of the passage of frequencies in a two-circuit system with artificially controlled intrinsic attenuation in the intermediate circuit.

Mityashev, B. N. Method of increasing the accuracy of pulse demodulation.

Samoilenko, V. I. Theory and calculation of frequency modulators using semiconductor control elements.

Krasnotsvetova, Z. G. On cross-distortions in the H. F. amplifier of a frequency modulation receiver.

Ostroumov, B. A. The "Nizhegorod" radio laboratory im V. I. Lenin—cradle of Soviet radio technology.

Program for Solid-State Circuits Conference

The 1959 Transistor and Solid-State Circuits Conference, sponsored by AIEE, Institute of Radio Engineers, and the University of Pennsylvania, will be held February 12-13, 1959, in Philadelphia, Pa.

Principal speaker at the formal opening of the 2-day Conference will be Dr. M. J. Kelly, president of Bell Telephone Laboratories, Inc.

The tentative technical program for the Conference follows.

Thursday, February 12

9:00 a.m. Session I: Solid-State Microwave Electronics I

Amplification by Nonlinear Reactance (A Survey). *A. Uhlir, Jr.*, Microwave Associates, Inc.

Low-Noise 400-Mc Reactance Amplifiers. *P. P. Lombardo*, Airborne Instruments Laboratory

Nonliner-Reactance (Parametric) Traveling-Wave Amplifiers for UHF. *R. S. Engelbrecht*, Bell Telephone Laboratories, Inc.

Large-Signal Characteristics of Three-Frequency Cavity Parametric Amplifiers. *K. L. Kotzebue*, Standford University

Multiple Frequency Parametric Devices. *Hsiung Hsu*, General Electric Company

9:00 a.m. Session II: Memory Techniques

Twistor Buffer Store. *K. Preston, Jr., Q. W. Simkins*, Bell Telephone Laboratories, Inc.

Impulse Switching of Ferrites. *R. E. McMahon*, MIT Lincoln Laboratory

Ferrite Apertured Plate Memories. *C. S. Warren*, Radio Corporation of America

Superconducting Memory. *C. J. Kraus*, International Business Machines Corporation

Thin Magnetic-Film Memories. *E. E. Bittmann*, Research Center, Burroughs Corp.

2:45 p.m. Session III: Application of New Devices I

Hall Effect Devices (A Survey). *W. J. Grubbs*, Bell Telephone Laboratories, Inc.

Superconductive Electronic Circuits (A Survey). *D. A. Buck*, Massachusetts Institute of Technology

Proposed New Cryotron Geometry and Circuits. *R. K. Richards*, consulting engineer, Wappingers Falls, N. Y.

An Electro-Optical Shift Register. *T. E. Bray*, Electronics Laboratory, General Electric Company

Miniaturized Ceramic Filters. *S. W. Tehon*, Electronics Laboratory, General Electric Company

2:45 p.m. Session IV: Linear Circuits

A New Approach to the Design of Low-Drift

D-C Amplifiers. *J. P. Warren,* Transitron Electronic Corp.

Design of a Transistorized 1.5 Megabi: Analog-to-Digital Encoder. *C. P. Villars,* Bell Telephone Laboratories, Inc.

A New Method of Automatic Gain Control for HF and VHF Transistor Amplifiers. *W. F. Chow, H. Lazar,* Electronics Laboratory, General Electric Company

Broadband Transistor Video Amplifiers. *W. E. Ballentine, F. H. Blecher,* Bell Telephone Laboratories, Inc.

Wide-Band Transistor Distributed Amplifiers. *L. H. Enloe, P. H. Rogers,* Applied Research Laboratory, University of Arizona

Friday, February 13

9:00 a.m. Session V: Applications of New Devices II

Silicon Controlled Rectifier Inverters. *H. R. Lowry, T. P. Sylvan, D. V. Jones,* General Electric Company

Applications of PNPN Triode Switches. *V. H. Grinich, I. Haas,* Fairchild Semiconductor Corp.

Some Circuit Applications of the Field Effect Current Limiter. *E. I. Doucette,* Bell Telephone Laboratories, Inc.

Circuit Applications of Stepping Transistors. *E. F. Kovanic,* Bell Telephone Laboratories, Inc.

Integrated Devices Using Direct Coupled Unipolar Transisto: Logic. *J. T. Wallmark,* RCA Laboratories, Princeton, N. J.; *S. M. Marcus,* RCA Defense Electronic Products Division, Camden, N. J.

9:00 a.m. Session VI: Switching Circuits I

A Comparison of Amplifying Devices of the Emitter-Control-Collector Variety (A Survey). *E. O. Johnson,* RCA Laboratories Division, Princeton, N. J.

Twistor Store—High-Current, High-Speed, Nonsaturating Transistor Drivers. *G. F. Abbott, Jr.,* Bell Telephone Laboratories, Inc.

A New All-Magnetic Logic System Using Simple Cores. *D. C. Engelbart,* Stanford Research Institute

Transistor Pulse Circuits for 160-Mc Clock Rates. *W. J. Giguere, J. H. Jamison, J. C. Noll,* Bell Telephone Laboratories, Inc.

Hyperfast Diffused-Silicon Diode and Transistor for Logic Circuits. *E. G. Ruppprecht, H. J. Patterson, P. Miller,* Bell Telephone Laboratories, Inc.

2:00 p.m. Session VII: Solid-State Microwave Electronics II

Solid-State Maser Amplifiers and their Applications (A Survey). *R. H. Kingston,* MIT Lincoln Laboratory

A Re-Entrant Resonant-Ring Maser Cavity. *J. W. Meyer,* MIT Lincoln Laboratory

A Unilateral Three-Level Maser Employing a Ruby Loaded Comb-Type Structure. *R. W. DeGrasse, E. O. Schulz-DuBois, H. E. D. Scovil,* Bell Telephone Laboratories, Inc.

Solid-State Microwave Power Source. *M. M. Fortini, J. Vilms,* Philco Corp.

Parametric Subharmonic Oscillators. *F. Sterzer, W. R. Beam,* RCA Laboratories Division, Princeton, N. J.

2:00 p.m. Session VIII: Switching Circuits II

Inverted Phototransistor as a Switched Modulator. *K. H. Beck, Jr.,* Minneapolis-Honeywell Regulator Co.

A Transistor Power Converter-Amplifier. *D. A. Paynter,* Electronics Laboratory, General Electric Company.

Physical Principles of Avalanche Transistor Pulse Circuits. *D. J. Hamilton, J. F. Gibbons, W. Shockley,* Stanford University.

Electrodeposited Twistor and Bit Wire Components. *S. J. Schwartz, J. S. Sallo,* The National Cash Register Co.

Rotational Remagnetization of Thin Films. *H. B. Callen,* Remington Rand Univac Division, Sperry Rand Corp.

Publication To List Conventions for Next Five Years

For the first time, American companies will be able to make plans as much as five years in advance for participating in or sending technical representatives to the many technical and engineering conventions held in the United States. National, regional, and state technical meetings through 1964 will be listed in the seventh annual issue of *Engineering and Technical Conventions,* to be published in January 1959.

Hitherto, this publication has listed meetings only for the coming year. The expanded coverage has been undertaken at the suggestion of the Engineers Joint Council (EJC) who feels that listing these technical events several years in advance will enable societies and organizations to avoid scheduling meetings that conflict in date or location with other conventions in their fields. EJC member societies and many others are co-operating in this project.

Subsequent yearly issues of *Engineering and Technical Conventions* will continue to list meetings, conferences, and conventions five years ahead. As it does now, the publication will give the date, place of the meeting, the sponsoring organizations, the title or subject of the meeting, and an alphabetical listing of these organizations and their addresses. As a new feature, an index of meetings by subject matter will also be included. The meeting schedules of more than 100 organizations are given and this number is expected to grow.

Engineering and Technical Conventions is prepared by Deutsch and Shea, Inc., technical manpower consultants, and is published by Industrial Relations News, 230 W. 41st St., New York 36, N. Y. Subscriptions, which include the annual Fall Supplement, are $4 per year.

Schedule Set for Papers for International Control Congress

American Automatic Control Council (A_2C_2) has announced review committees and schedules for United States papers to be presented at the first Congress of International Federation of Automatic Control (IFAC) in Moscow, USSR, in 1960.

Soviet hosts for the 1960 meetipg have prepared an ambitious agenda for technical sessions. It covers three main areas—theory, components and measurement, and applications. Papers on automatic control theory will cover discrete data systems, continuous data systems, systems using computing devices, optimalizing, multivariable systems, systems including a human operator, information theory, switching theory, stochastic processes, and simulators.

Papers on components and measurements will be sought covering the design and performance of transducers, amplifiers, computers, logic elements, regulators, telemetry, final control elements, characteristics of components, methods of dynamic testing, and reliability.

Each paper on application will pertain to a particular industry or type of controlled equipment. Typical examples: electrical machines, power systems, petroleum processing, chemical processing, ore refining, metal production, metalworking, transportation, materials handling, nuclear reactors, and heating and air conditioning.

United States papers may be submitted in the following ways.

1. Directly to a member of the A_2C_2 Review Committee:

Chairman—E. M. Grabbe, The Thompson Ramo Wooldridge Corp., P.O. Box 45215, Airport Station, Los Angeles 45, Calif.

Automatic Control Theory—John Truxal, Electrical Engineering Department, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Components and Measurements—John Johnston, Jr., Instrument Department, Engineering Services Division, E. I. du Pont de Nemours & Co. (Inc.), Louviers Building, Newark, Del.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until January 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistand Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before January 26.

57-896 A Tubeless Industrial Telemeter of the Frequency Type. *D. E. Kotas, J. Parnell*

58-1096 Sag-Tension Calculation Program for Digital Computer. *B. M. Pickens*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

Industry Applications—D. M. Boyd, Universal Oil Products, Des Plaines, Ill.

2. Through the appropriate professional divisions of the societies affiliated with A_3C_3:

American Society of Mechanical Engineers, Instruments and Regulators Division, Chairman—D. J. Bergman, Universal Oil Products, Des Plaines, Ill.

AIEE, Feedback Control Committee, Chairman—H. Chestnut, General Electric Company, 1 River Road, Schenectady 5, N. Y.

Institute of Radio Engineers, Professional Group on Automatic Control, Chairman—J. E. Ward, Servomechanisms Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.

Instrument Society of America, R. P. Bigliano, Engineering Department, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Del.

American Institute of Chemical Engineers, Process Control Committee, Chairman—D. M. Boyd, Universal Oil Products, Des Plaines, Ill.

3. Directly to the Congress chairman, A. M. Letov, Institute of Automatics and Telemechanics, Kalanchovskaya 15 A, Moscow I-53, USSR.

Deadlines are: March 1, 1959, for abstracts and rough drafts of outlines to be in the hands of the A_3C_3 Review Committee, and July 15, 1959, for completed papers to be delivered to A_3C_3 Review Committee.

The A_3C_3 Review Committee will review and evaluate for publication all United States Papers. Papers may be presented in English. Soviet hosts to the Congress will handle translation into Russian and will publish Russian proceedings. A_3C_3 will arrange for publication of English proceedings.

For more information, contact: W. E. Vannah, Secretary-Treasurer, American Automatic Control Council, 330 W. 42 St., New York 36, N. Y.

AIEE Sacramento Section Contributes to Building Fund

A contribution of $500 to the United Engineering Center Building Fund was recently presented to United Engineering Trustees, Inc., by the Sacramento Section of the Institute.

In acknowledging the contribution, L. M. Goldsmith, chairman of the AIEE Member Gifts Committee, said, "This gift from the Sacramento Section is valued for itself and also as an expression of enthusiasm which should be inspiring to other Sections and individual members in District 8 and throughout the Institute."

Nominations Invited For 1959 AIEE Medal in Electrical Engineering Education

The Recognition Awards Committee announces that it is now ready to receive nominees for the 1959 AIEE Medal in Electrical Engineering Education which will be presented at the Fall General Meeting in Chicago, October 11-16, 1959. Nominations must be received in the office of the Secretary of the Recognition Awards Committee, Mrs. A. L. Landres, located at AIEE Headquarters, not later than May 1, 1959.

The Committee invites members to submit names of nominees. Such nominations may be made by procuring a nomination form from the Secretary of the Recognition Awards Committee. The form should be accompanied by at least two supporting letters from others who are familiar with the accomplishments and the qualifications of the nominee. It is desirable that at least one letter come from a former student of the nominee.

All previous nominations received in connection with the award of this medal must be renominated by letter to Institute Headquarters. Supplementary information on these past nominees may, of course, be forwarded with the renomination for attachment to the present file.

The award will be made to a teacher of Electrical Engineering based upon his excellence in teaching and his ability to inspire students to higher achievements; on his contributions to the teaching of Electrical Engineering by text books and by writings on engineering education; on his active participation in the work of the professional and educational societies; and on his contributions to teaching and the profession through research, engineering achievements, and technical papers.

New Subsection Holds First Meeting

The initial meeting of the Upper Monongahela Subsection of AIEE was held Thursday night, October 30, at the Fairmont Elks Lodge, Fairmont, W. Va. The response to the invitations for this initial meeting was very encouraging as 31 persons were in attendance.

The Upper Monongahela Subsection covers the territory of the Pittsburgh Section which is located south of the Mason and Dixon Line, and includes the following counties of West Virginia: Barbour, Doddridge, Harrison, Lewis, Marion, Monongalia, Preston, Taylor, Tucker, Tyler, Upshur, and Wetzel. The principle cities in this area are Morgantown, Kingwood, Fairmont, Grafton, Clarksburg, Salem, Weston, and Buckhannon.

R. D. Brown, chairman of the new Subsection, was chairman for the meeting. The other officers of the Subsection are Prof. E. C. Jones, vice-chairman; W. S. Schmidt, secretary-treasurer; and Prof. M. J. Smith, member-at-large of the Executive Committee.

The guest of honor and principle speaker was R. N. Wagner, past chairman of the Pittsburgh Section and chief engineer of the Aluminum Company of America. Mr. Wagner, who was introduced by Prof. M. J. Smith of West Virginia University, gave a very interesting and instructive talk on the purpose, aims, and organization of the AIEE.

An explanation of the various grades of membership was given by L. H. Weeks.

Prof. Jones submitted the proposed Bylaws which were read, thoroughly discussed and, together with the proposed changes, adopted.

Prof. Smith gave a very interesting and illuminative talk on the proposed United Engineering Building. He stressed the importance to all members of actively and financially supporting the building program.

OFFICERS and guest of honor at the initial meeting of the Upper Monongahela Subsection of AIEE were (*left to right*): Prof. M. J. Smith, member-at-large of Executive Committee and professor of electrical engineering, West Virginia University; R. N. Wagner, chief electrical engineer for Aluminum Company of America and immediate past chairman of Pittsburgh Section AIEE; R. D. Brown, chairman of Subsection and chief engineer of Monongahela Power Company; Prof. E. C. Jones, vice-chairman of Subsection and head of electrical engineering department at West Virginia University; and W. S. Schmidt, secretary-treasurer of Subsection and special staff consultant for Monongahela Power Company.

Los Angeles Section Holds First Meeting

"Water Problems and the Electrical Engineer" was the subject of an address by Max Bookman as he spoke to approximately 150 members of the Los Angeles Section of the AIEE during their first dinner meeting of the 1958-59 year in October.

Mr. Bookman is the district engineer of the Southern California District of the Department of Water Resources, State of California. He discussed methods of developing new sources of water, such as import, storage, salt water conversion, and sewage conversion. During his discussion, Mr. Bookman outlined the California water plan and the objectives of the Feather River Project, where surplus water from the northern part of the state is imported to drought areas of southern California. He outlined the electrical features of the project, such as power requirements, power generation, and control of the system.

At the same meeting, H. A. Lott, past chairman of the Los Angeles Section (1957-58), received his Past Chairman's Certificate from the present chairman (1958-59), E. D. Barcus. Mr. Lott is with the Southern California Edison Company, and Mr. Barcus is with the Pacific Telephone & Telegraph Company.

H. A. LOTT (left), past chairman of the Los Angeles Section of the AIEE (1957-58), receives his Past Chairman's Certificate from E. D. Barcus, the present chairman of the Los Angeles Section. Mr. Lott is with the Southern California Edison Company, and Mr. Barcus is with The Pacific Telephone & Telegraph Company.

AIEE Committee Sponsors Inspection Trip to Leadville

More than 65 members and guests of the AIEE Transmission and Distribution Committee convened recently for a meeting in Denver, Colo., followed by an inspection trip to Leadville, Colo.—the "Cloud City"—situated almost two miles above sea level. During the meeting in Denver, L. M. Robertson, chief electrical engineer of the Public Service Company of Colorado, distributed folders describing the high-voltage, high-altitude research project at Leadville which the committee was to inspect on the following day. While members referred to this 32-page booklet, Mr. Robertson also gave a very interesting description of the historical country which would be covered on the way.

The group which made the inspection trip viewed the sending end of the experimental line at the Leadville substation. In summary, the following was explained to the group:

1. The Public Service Company of Colorado anticipates construction of transmission lines of higher voltage than the existing 115-kv circuits some of which will have an average altitude of 10,000 feet and cross the Continental Divide passes of 12,000 and 13,000 feet altitudes in extremely rugged terrain. Construction is difficult and mechanical loading during storms severe. Therefore, simple tower design and minimum conductor size with good corona and radio influence is important.

2. The company has entered into a joint program with several manufacturers to evaluate corona, radio influence, and mechanical line design at high altitudes.

3. A transformer has been installed adjacent to Leadville substation supplying the new test line with voltage to ground varying from 153 to 289 kv. The line is 6,700 feet long with maximum span length of 2,072 feet and at an altitude of 10,400 feet. Structures include steel tower and steel and wood H-frames.

4. Conductors are single, two conductor bundle and a four conductor bundle which has been reduced to a three and then to a two conductor bundle.

5. Instrumentation is automatic recording of voltage, current, corona loss, radio influence, and weather conditions. Motor-operated switches disconnect two conductors for a test on the third at periodic intervals.

6. To date the data has shown the corona loss to be higher, and the corona starting voltage to be lower than measured at lower altitudes. While this result was to be expected, appreciably more data is going to be obtained in order to develop more reliable curves relating corona and radio characteristics to variations in altitude.

Fortescue Fellowship Applicants Must File by February 15, 1959

Funds have been made available for one or more Charles LeGeyt Fortescue Fellowships for 1959-60. The amount of the award has been fixed at $2,500. The awards are made to postgraduate students in the field of electrical engineering who have received their baccalaureate degree from a duly recognized technical school in the United States or Canada.

Candidates for the Charles LeGeyt Fortescue Fellowships should file applications on the form provided by AIEE so that they reach the Chairman of the Fellowship Committee by February 15, 1959.

THE AIEE Transmission and Distribution Committee inspection group witness a demonstration on the high-voltage substation and test line at Leadville, Colo.

Awards will be made not later than April 2. Copies of the application forms are available at accredited colleges or by writing to the Secretary of the Professional Development and Recognition Department, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

The Charles LeGeyt Fortescue Fellowship, sponsored by AIEE, was established in 1939 as a memorial to Charles Fortescue in recognition of his valuable contribution to the electric power industry. To this end, the Westinghouse Electric Corporation, with which Dr. Fortescue was associated throughout his professional career, set up a trust fund of $25,000 to provide graduate fellowships in electrical engineering.

The successful candidates are selected by the AIEE committee which administers the fund.

It is intended that candidates shall pursue their studies at accredited engineering schools and engage in research problems meeting the approval of the Fellowship Committee. To be eligible, the student must have received a bachelor's degree from an accredited college by the time his work under the fellowship would begin, provided he does not hold or subsequently receive any other fellowship which carries a stipend greater than the tuition required by the institution at which the graduate work is to be undertaken.

Symposium on Millimeter Waves

Millimeter Waves will be the subject of the ninth international symposium of the Polytechnic Institute of Brooklyn, Microwave Research Institute, to be held in the auditorium of the Engineering Societies Building, New York, N. Y., March 31-April 2, 1959, under the co-sponsorship of the Air Force Office of Scientific Research, U.S. Army Signal Research and Development Laboratory, Office of Naval Research, and the Institute of Radio Engineers. The symposium is intended to highlight the present state of research in, and applications of, millimeter wave technology. Accordingly, the program will be devoted to invited and contributed papers treating the generation, transmission, control, measurement, and detection of millimeter wave energy. In addition, source material and significant advances in basic supporting fields will be summarized in tutorial papers chosen from appropriate fields in physics and engineering. A more detailed indication of topics which fall within the scope of the symposium follows.

Interaction of millimeter waves and materials. Hall effect circuits, circuits utilizing ferromagnetic and paramagnetic resonances, cryogenic circuits, ferrite devices, equivalent circuit representations for active and anisotropic structures.

Solid-state active millimeter circuits. Maser and parametric amplifiers and oscillators, solid-state mixers and frequency multipliers, duplexing and switching circuits, active matching elements, discontinuities in active systems.

Millimeter electron tubes. Oscillators and amplifiers such as klystrons, magnetrons, backward wave oscillators, etc., Cerenkov millimeter sources, relativistic electron beam harmonic generators and radiators, millimeter-wave interaction with plasmas.

Radiating circuits and antennas. Antennas for millimeter waves, equivalent circuits for radiating discontinuities, radio astronomy.

Coupled line, multimode, and nonconventional transmission systems. Periodic structures in multimode waveguide, anisotropic media, surface waveguides, quasi-optic techniques, equivalent circuits for discontinuities in multimode or nonconventional waveguides.

Millimeter components. Filters, transformers, directional couplers, rotary joints, quasi-optic component techniques.

Millimeter circuit measurement techniques. New measurement methods, measurement techniques for nonreciprocal and active circuits, diagnostic measurements of plasmas with millimeter waves.

The closing date for submission of papers and/or 100 word abstracts is January 30, 1959. All correspondence should be addressed to: Prof. H. J. Carlin, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N. Y.

Marketing Manager Addresses AIEE Fall Textile Conference

A planned maintenance program was suggested recently as a means of improving the profit picture for the textile industry.

C. E. Sutton, Jr., marketing manager for General Electric Company's (GE) service shops department, said a program of "Productive Maintenance" could help assure the future of American textile production.

Speaking before the AIEE Fall Textile Conference held in Raleigh, N.C., October 30-31, 1958, Mr. Sutton declared, "With an increasing demand for textile goods, today's management cannot afford to lose production as a result of mechanical or electrical equipment failure."

He explained that a properly engineered maintenance program will keep equipment failure to a minimum. Management must become convinced that money properly spent on maintenance actually adds to profits, he said.

"If more money spent for maintenance can increase the total output from a given machine at a lower per-unit cost, then the maintenance money should definitely be spent," Mr. Sutton said.

The textile industry is engaged in a life and death competitive struggle, particularly where the after-tax-profit is low, he said. "It needs the best maintenance system which can be devised to give it maximum output at minimum cost," Mr. Sutton declared.

He predicted a strong potential for the textile industry, pointing out that this year's "vintage crop" of babies will require 62 million suits of clothing and more than 2 billion shoe-strings in their lifetime.

The 2-day Conference held at the North Carolina State College, School of Engineering, was sponsored by the Textile Industry Subcommittee and the North Carolina Section of the Institute and the School of Textiles and the Department of Electrical Engineering at the College.

AIEE Fellow Honored by SES

V. L. COX (F '50), manager, laboratories department, General Electric Company, was made fellow of the Standards Engineers Society (SES) at the organization's annual convention held September 22-24, 1958, at the Benjamin Franklin Hotel, Philadelphia, Pa. Mr. Cox (right) received the award from W. L. Healy, past-president and fellow of the SES.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Ghaffar Farman-Farmanian

AIEE Member Wins Nobel Prize

Ghaffar Farman-Farmanian (AM '58) of Tehran, Iran, has been awarded the 1958 Alfred Nobel Prize for his paper "General Analysis and Stability Study of Finite Pulsed Feedback Systems," AIEE Transactions Vol. 22. Mr. Farman-Farmanian is a native of Tehran, having been born there 29 years ago. He was educated in England, and received his first degree in electrical engineering from Loughborough College in 1951. He was awarded the M.S. degree in E.E. by the University of Illinois in 1953, and the Ph.D. in E.E. from the University of California in 1958.

The Alfred Nobel Prize is administered by the American Society of Civil Engineers (ASCE), and awarded to a member of ASCE, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Mechanical Engineers, AIEE, or the Western Society of Engineers for a paper of exceptional merit by an author who has not passed his 31st birthday at the time the paper was submitted. The selection is made by a committee representing the participating societies. AIEE is represented by Prof. F. E. Canavaciol of the Polytechnic Institute of Brooklyn.

Symposium at the University of Vermont

The Vermont Subsection of the AIEE and the Engineering Departments of the University of Vermont will sponsor jointly a Symposium on the Nuclear Power Plant, Engineering Problems of Planning, Construction, and Operation, on May 14—15, 1959, at the Universtiy of Vermont, Burlington.

SENEWS Available to AIEE Members and Others

SENEWS, a newsletter prepared by the Science Education Subcommittee of the Joint Computer Committee sponsored by AIEE, Association for Computing Machinery (ACM), and Institute of Radio Engineers (IRE), is now being made available to AIEE members and other interested persons.

The newsletter is addressed primarily to computer oriented members of the three societies to aid them in promoting interest and knowledge in computing among high school students. SENEWS also wants to communicate directly with secondary school teachers and other science-education groups, to report on their projects and problems and offer help in bringing together all those interested in such projects.

Copies of SENEWS are being mailed to AIEE members who, through a survey, have indicated an interest in computing devices. Others may obtain copies—free to AIEE members, 30¢ a copy to nonmembers—by writing to AIEE Headquarters, 33 W. 39th St., New York 18, N. Y. Copies of Vol. 1, No. 1, No. 2, and No. 3 are available.

AIEE FELLOWS ELECTED

Board of Directors Meeting, September 30, 1958

Delmar L. Brown (AM '35, M '45), superintendent of the testing department, Portland General Electric Co., Portland, Oreg., has been transferred to the grade of Fellow in the AIEE. ". . . for contributions to testing and performance of power system components." Mr. Brown was born March 28, 1909, in Silverton, Oreg. He was graduated from Oregon State College with the B.S.M.E. degree in 1931, and was employed by Portland General Electric Co. as a power plant engineer in that year. In 1933, he became chemist and, in 1945, was advanced to his present position of superintendent of the testing department. He is the author of technical papers and articles in the fields of wood preservation, combustion of wood fuels, reclamation of insulating oils, domestic heat pumps, and protection systems for communication lines. Mr. Brown has served AIEE as chairman of the Portland Section in 1941-42, and as a member of the Instruments and Measurements Committee (1948-55), Power System Communications Committee (1958-59), and Special Instruments and Auxiliary Apparatus Committee (1956-58). He is a registered professional engineer in Oregon, and was president of the Professional Engineers of Oregon in 1944. In an independent capacity, he has been chief engineer and is now secretary-treasurer of the Valley Telephone Company serving five towns in Oregon, and is owner of the Scanitran Company engaged in research and development of electronic automobile control and communications from highway sound tracks based on his original technical paper and patent in this field.

Bernard M. Cain (AM '34, M '46), manager, generator advance engineering, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design of small motors and improved cooling and performance of large generators." Mr. Cain was born in Hastings, Mich., April 20, 1908. He received a bachelor's degree in E.E. in 1929 and the degree of M.S. in 1930, both from the University of Michigan. In 1930, he joined the General Electric Company as a student engineer and shortly thereafter entered the company's advance engineering training program. In 1933, he was assigned to the industrial engineering department in Schenectady and in 1936 he was transferred to the motor engineering department in Lynn, Mass. In this latter assignment, he was given responsibility for design of integral horsepower single-phase motors and was consultant on the design of fans and ventilation systems for motors and generators. In 1947, he was given a special assignment to the motor engineering department at San Jose, Calif., for the development of a new product line at that plant. In 1949, he transferred to large steam turbine-generator engineering in Schenectady. In this assignment, he has directed developments associated with the introduction of a completely new armature insulation system called "micapal," the "air-gap pick-up" conductor cooled rotor and liquid cooled stator windings. He became head of generator advance engineering in 1954. Mr. Cain is a member of Tau Beta Pi, Phi Kappa Phi, American Society of Mechanical Engineers, and the New

D. L. Brown

B. M. Cain

York Society of Professional Engineers. He has served on the AIEE Electrical Machinery Committee (1943-47), Rotating Machinery Committee (1947-48).

Wallace Lewis Cassell (AM '25, M '44), professor of electrical engineering, Iowa State College, Ames, Iowa, has been transferred to the grade of fellow in the AIEE ". . . for contributions to electrical curricula and inspirational teaching." Prof. Cassell was born in Abilene, Kans., on June 19, 1899. He received the B.S. degree in E.E. from the University of Colorado in 1922, the professional degree of electrical engineer from the same institution in 1926, and the M.S. in E.E. degree from Purdue University in 1946. In 1922, he joined the General Electric Company in the radio engineering department, leaving in 1924 to build and operate broadcasting station WSAR in Fall River, Mass. In 1925, he returned to the University of Colorado as instructor in electrical engineering. He was appointed assistant professor in 1928 and associate professor in 1932. In 1939, he became associate professor of electrical engineering at Iowa State College. Since 1941, he has held a professorship in that department. In 1957, Iowa State College conferred upon him the Anson Marston Distinguished Professorship in Engineering. Prof. Cassell served as acting head of electrical engineering at Iowa State College during 1942-44, and as a research consultant to the Naval Ordnance Laboratory during 1944-45. He is a member of Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, and Sigma Tau. He is a senior member of the Institute of Radio Engineers and a member of the American Society for Engineering Education. Mr. Cassell has been active in the Institute as chairman of the Denver Section (1934-35), chairman of the Iowa Section (1947-48), and AIEE vice-president for the Great Lakes District (1952-54). He has served on the Education Committee (1947-49), Board of Directors (1952-54), and Constitution and Bylaws Committee (1956-58).

Paul Southworth Colby (AM '37, M '44), engineering consultant, operating and engineering department, Carolina Power & Light Co., Raleigh, N. C., has been transferred to the grade of fellow in the AIEE ". . . for contributions to planning and execution of power transmission and distribution." Mr. Colby was born in Junction City, Kans., on October 24, 1905. He began his utility career by working as an electrician's helper and as operator for the Public Service Company of Colorado, Denver, in 1926. After receiving his B.S. degree in E.E. from Kansas State College in 1929, he joined the Kansas Gas and Electric Company, Wichita. In 1941, he was employed by Central Illinois Public Service Company, Springfield, as distribution engineer. In 1942, he joined Ebasco Services, Inc., New York, N. Y., as electrical engineer in the consulting engineering department and in 1949 he was promoted to general engineer. During 1951, he was temporarily assigned to Overseas Consultants, Inc., to make investigations and consult with Japanese engineers on coordinated development and operation of the reorganized electric utility systems. In 1952, he joined Carolina Power & Light Company as engineering consultant. Mr. Colby is a registered professional engineer in New York and North Carolina. He is a member of Phi Kappa Phi, the North Carolina Society of Engineers, the Edison Electric Institute Electrical Equipment and Systems Committee, and chairman of the Transmission and Large Substations Committee of the Southeastern Electric Exchange. Mr. Colby has served as chairman of the Wichita Section of the AIEE (1940-41), chairman of the Eastern North Carolina Subsection (1956-57), member of the Protective Devices Committee (1953-58), and member of the Substations Committee (1954-57). He has written and presented several papers for AIEE Section and Subsection meetings and industry association meetings.

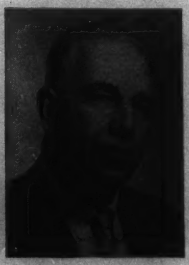
Harold S. Endicott (AM '36, M '46), dielectric measurements engineer, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the techniques and precision of dielectric measurements." Mr. Endicott was born in Fremont, Iowa, on December 10, 1901. He received the B.S. degree in E.E. from the California Institute of Technology in 1923 and joined the General Electric Company as a test engineer that same year. The following year, he entered the Insulation Research Section of the Pittsfield Works Laboratory, where he participated in the development and application of Pyranol to capacitors and transformers. In 1934, he transferred to the Electrical Research Section of the same Laboratory. There his work consisted of research on electrical insulation and development and application of electrical measurements. He developed a test method for capacitor paper which has had wide acceptance and is being adopted as an ASTM (American Society for Testing Materials) method. He collaborated in the design of automatic equipment for making dielectric breakdown tests on oil and recording the results. This resulted in three joint AIEE papers on the effect of area on oil breakdown. In 1954, he transferred to the General Engineering Laboratory of the company in Schenectady, where he had the responsibility for consulting on dielectric measurements throughout the company. He directed a project which succeeded in producing capacitors capable of operation at 500 C. Mr. Endicott is a registered professional engineer in Massachusetts and New York and is active in the National Society of Professional Engineers. He has served as chairman of several ASTM Committees. He is a member of the AIEE Measurements on Dielectrics Subcommittee and the Thermal Evaluation Subcommittee.

Henry F. Rempt (AM '43, M '48), division engineer in charge of the Electronics and Armament Systems Division, Lockheed Aircraft Corporation, Burbank, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to proof tested applications of power and electronics for aircraft." Mr. Rempt was born in St. George, S. I., N. Y., on October 23, 1908. He attended Columbia University evenings taking the industrial engineering course. He joined the Holmes Electric Protective Company, a subsidiary of the American Telephone & Telegraph Company, as an electrical draftsman in 1927. In 1939, he moved to California where he became a senior layout engineer for the Lockheed Aircraft Corporation. In 1941, he became a design group engineer and subsequently was in charge of the electrical and electronics systems design for the *XP-49* Fighter plane and the *P-38A*, one of the first pressurized single-seat aircraft. He was responsible for the electrical design of the unique pressurization equipment for these aircraft. In 1943, he was given the responsibility for the design of the electrical and communication systems in the *P-80* Shooting Star aircraft, one of the first jet planes in the United States. He then was chosen to establish a special electrical research organization with the assignment of exploiting and developing high-voltage and high-frequency alternating current generation systems for

W. L. Cassell

Siddall Studio

P. S. Colby



H. S. Endicott

H. F. Rempt

aircraft. Under his direction, there resulted the first complete multiengine electrical generating system test facility in the United States. In 1946, he was assigned to the *R6O* Constitution aircraft project in charge of the electronics and radio design. In 1947, he was appointed electrical staff engineer with the responsibility for electrical and electronic technical design in all Lockheed aircraft. Subsequently, he was also given the responsibility of the Armament Staff Office. In 1956, he was appointed a division engineer in charge of the Electronics and Armament Systems Division. Mr. Rempt has been vice-chairman and a member of the Air Transportation Committee for many years. In 1951, he was appointed to the Advisory Staff for Aircraft Electrical Systems by the U. S. Air Force and Bureau of Aeronautics. He was a member and presented a technical paper to the British Advisory Staff on Aircraft Electrical Systems in London, England. He is a co-author of the Aircraft Industries Association Design Manual on Aircraft Electrical Installations. He is the founder and past president of the Aircraft Electrical Society, a senior member of the Institute of Radio Engineers and a member of the Institute of Aeronautical Sciences. Mr. Rempt is a charter member of the Institute of Navigation, and this year was elected president. He is the author of several technical papers and holds a number of patents in the fields of control devices and installation equipment. He is a registered professional engineer in the State of California.

AIEE PERSONALITIES

H. W. Bode (M '41, F '51), director of research in the physical sciences, Bell Telephone Laboratories, has been elected a vice-president. Dr. Bode, who has been associated with Bell Laboratories since 1926, will be in charge of one of two vice-presidential areas devoted to military development. He is a fellow of the Institute of Radio Engineers and the American Physical Society, and a member of the American Mathematical Society and Phi Beta Kappa.

F. P. Fairchild (M '55), chief engineer, Public Service Electric and Gas Company of New Jersey, and **V. F. Estcourt** (M '48), general superintendent of steam generation for the Pacific Gas and Electric Company of California, have won national awards from the American Society of Mechanical Engineers (ASME). Mr. Fairchild received the (ASME) George Westinghouse Gold Medal for "progress in the art of designing and installing high efficiency steam generating stations and superiority in his ability to achieve prudent and consistent advances in the field." Mr. Estcourt received the Prime Movers Committee Award for a paper, "Plant Management and Other Factors Affecting Maintenance Costs in Steam Generating Stations." Mr. Estcourt is a member of the AIEE Power Generation Committee (1953-59).

H. C. Frost (AM '35, M '58), assistant chief engineer, Corn Products Refining Company, Chicago, Ill., has assumed the presidency of the Instrument Society of America (ISA). A graduate of the University of Toledo, Mr. Frost has participated in the activities of the Chicago Section of ISA and in the national organization since its beginning in 1946.

F. H. Gerlach (AM '42, M '52), vice-president and engineering manager, Lamb Electric Co., Kent, Ohio, has been named president and general manager of Han-Kor, Inc., Cleveland, Ohio.

B. G. Hatch (AM '41), sales engineer, gas turbine department, General Electric Company, retired October 1, after more than 39 years with the company. The author of several technical articles, Mr. Hatch has delivered more than 120 lectures on the application of gas turbines before local and district meetings of AIEE, American Society of Mechanical Engineers, colleges, and other organizations.

W. R. Milby (AM '52), assistant director of customer services, The Detroit Edison Company, has been named director of customer services for the company's Detroit division. Mr. Milby has served on the AIEE Domestic and Commercial Applications Committee (1952-59).

A. A. Halacsy (M '50), engineer, Delta-Star Electric Division of the H. K. Porter Co., Philadelphia, Pa., has been appointed as a staff development specialist for the Federal Pacific Electric Company, Newark, N.J. **G. O. Perkins** (AM '50), engineer, I-T-E Circuit Breaker Co., Philadelphia, Pa., has been named Federal Pacific's new manager of the development engineering department, Eastern Switchgear Division, at the company's Scranton, Pa., plant.

R. A. Vanina (AM '44), of the Electro Dynamic Division of General Dynamics Corporation, has been appointed assistant division manager–sales.

E. G. Warren, Jr. (AM '54), of the Humble Oil & Refining Company, has been promoted to senior electrical engineer in Technical Division at the company's Baytown, Texas, refinery.

J. E. Watson, Jr. (AM '51), manager of the Miami District of Allis-Chalmers Manufacturing Company's Industries Group, has been appointed manager of the firm's New Orleans district. **W. E. Scott** (AFFIL '57), sales representative in the Charlotte, N. C., district, has been named manager of the Miami district.

C. W. Wilson (AM '40), Chicago branch sales manager of Exide Industrial Division, The Electric Storage Battery Company, has retired after nearly 43 years of service with the firm. Mr. Wilson is a member of the Exide Quarter Century Club, the Chicago Diesel Club, Locomotive Maintenance Officers Association, Western Railway Club, and the National Independent Telephone Association.

A. H. Waynick (M '55), professor and head of the electrical engineering department and director of the Ionosphere Research Laboratory, Pennsylvania State University, has been appointed program director for engineering sciences, Division of Mathematical, Physical, and Engineering Sciences, National Science Foundation. Dr. Waynick has served on the AIEE Basic Sciences Committee (1949-52) and Electronic and High-Frequency Instruments Committee (1956-58). He is a fellow of the Institute of Radio Engineers and a member of the American Geophysical Union, American Society for Engineering Education, Eta Kappa Nu, Sigma Pi Sigma, Sigma Xi, and the U.S.A. National Committee of the International Scientific Radio Union.

W. G. Dow (AM '19, F '48, Member for Life), professor of electrical engineering, University of Michigan, Ann Arbor, has been appointed chairman of the department of electrical engineering. Prof. Dow joined the College of Engineering faculty in 1926 as an instructor in electrical engineering, was promoted to assistant professor in 1929, to associate professor in 1938, and since 1945 he has held the rank of professor. He has served on the following Institute Committees: Electronics (1942-59, chairman 1949-51); Industrial Power Applications (1942-44); Technical Program (1949-52); Standards (1949-50); Science and Electronics Division (1949-59); Computing Devices (1950-59); Award of Institute Prizes (1951-53); and Research (1954-59).

Arthur Belefant (AM '57) has recently joined The Frank E. Basil Co., Consulting Engineers, as chief electrical engineer and assistant project manager of their Athens, Greece, office.

G. H. Cole (M '49), consulting engineer, Armco Steel Corporation, Middletown, Ohio, has retired after more than 29 years of service. Mr. Cole joined Armco in 1929 and in 1931 was appointed associate director of research in charge of magnetic materials research. He served in this position until 1955 when he became consulting engineer. Mr. Cole has been active in the American Society for Metals, American Society for Testing Materials, and American Society of Tool Engineers.

Herbert Freeman (AM '49, M '56), has been appointed visiting associate professor in the department of electrical engineering at the Massachusetts Institute of Technology. Dr. Freeman will be on leave of absence from his position as department head for advanced studies with the Sperry Gyroscope Company, Great Neck, N. Y.

H. H. Kerr (AM '17, F '44, Member for Life), retired vice-president of the Toledo Edison Co. has been named a fellow of the American Society of Mechanical Engineers. Mr. Kerr served as AIEE vice-president for District No. 11 (1956-58), on the Board of Directors (1956-58), and as a

member of the Electrical Machinery Committee (1942-46). He is a member of the Ohio Society of Professional Engineers, a past president of the Engineering Society of Toledo, and has been a member of several committees of the Association of Edison Illuminating Companies.

F. K. McCune (AM '38, F '49), vice-president and general manager of the Atomic Products Division, General Electric Company, has been elected president of the Atomic Industrial Forum, Inc. Mr. McCune has been a director of the Forum since 1953 and a vice-president since 1955. He has served on the following AIEE Committees: Transfers (1946-48); Management (1951-57, chairman 1953-55); Planning and Co-ordination (1953-55); and Technical Operations (1953-55).

Rufus Oldenburger (M '55), professor of mechanical engineering at Purdue University, and president of the American Automatic Control Council, has been elected corresponding member of the Swiss Association of Automatic Control.

A. L. Short (AM '39), sales representative, Boston, Mass., office, Allis-Chalmers Manufacturing Company, has been appointed Northeast regional representative for distribution and transmission equipment.

A. N. Goldsmith (M '15, F '20), consulting engineer in the electronics and motion picture fields, has been elected to the Board of Directors of RCA Communications, Inc., Dr. Goldsmith has served as president of the Institute of Radio Engineers (IRE) and of the Society of Motion Picture and Television Engineers. He is a fellow of IRE, American Physical Society, American Association for the Advancement of Science, Acoustical Society of America, Optical Society of America, and International College of Surgeons.

A. D. Hinckley (AM '27, M '38), executive secretary of the Illuminating Engineering Society (IES) for the past 14 years, has been named managing director, a post recently created to relieve the society's president of many detailed operating duties resulting from the growth of the organization. Mr. Hinckley became associated with the IES as a member in 1931 while teaching electrical engineering at Columbia University. In 1939, he served a one-year term as chairman of the IES New York Section and later became national general secretary and a director. For the final 10 years of his service at Columbia, where he had become an instructor in 1928, he was assistant to the dean of engineering.

F. R. Lack (M '37, F '48), has been elected a director of Hazeltine Corporation, Little Neck, L. I., N. Y. Mr. Lack retired in August 1958 as a director and vice-president of the Western Electric Company, in which capacity he had served since 1942, after being with Western Electric since 1911. Mr. Lack has served as a director of the Electronics Industry Association and the Armed Forces Communications and Electronics Association. He is a fellow of the Institute of Radio Engineers and the American Association for the Advancement of Science, and a member of the American Physical Society. He served on the AIEE Communication Committee (1938-44).

R. L. Lampton (AM '55), has joined the Control Systems Division, The Ramo-Wooldridge Corporation. Mr. Lampton was formerly associated with Nortronics and Sperry Rand.

J. B. Gardner (AM '48), electrical engineer, The Kerite Company, has been appointed assistant chief engineer. Mr. Gardner has served the firm since 1947 as an electrical engineer at the company's manufacturing plant at Seymour, Conn. He will continue in his new position to operate from the same plant. He is a member of the National Research Council.

C. E. Smith (AM '36), production engineer, Detroit Edison Company, will be granted a leave of absence next Spring for extensive training in reactor technology at one or more operating reactor installations, after which he will assume a new responsibility as shift engineer at the Enrico Fermi Atomic Power Plant between June 1959 and January 1960, during non-nuclear operation of the reactor being built by the Reactor Development Company near Monroe, Mich.

R. J. Wondra (AM '56), who recently completed Allis-Chalmers Manufacturing Company's training course for graduate engineers, has been assigned to the switchgear department.

J. L. White (AM '51), manager of military programs, Dage TV Division of Thompson Products, Inc., has joined the technical staff of the Control Systems Division, The Ramo-Wooldridge Corporation, Los Angeles, Calif.

OBITUARIES

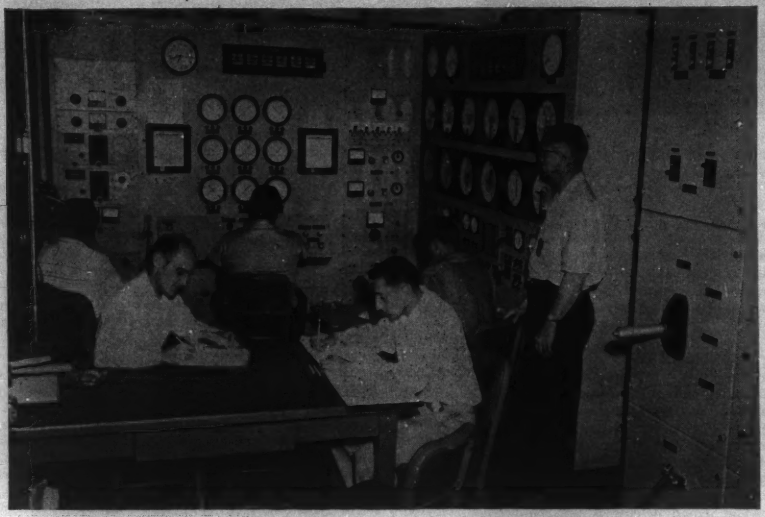
Harold Stolp Johnson (AM '19, Member for Life), retired, died recently. Mr. Johnson was born in Chicago, Ill., on July 25, 1888. He graduated from Massachusetts Institute of Technology in 1913 with a B.S. degree in E.E. Mr. Johnson was self-employed in New York, N. Y., and Chicago, Ill., in electrical engineering prior to his joining the Bell Laboratories of the Western Electric Company as a development engineer in 1917. From 1925 to 1927, he was a consultant in electrical engineering at Port Washington, N.Y., and then joined Electrical Research Products, Inc., of New York, as a specialist in theater sound engineering. From 1932 to 1943, he engaged in independent consulting work in Southern California. In 1944, he joined The Seismic Geophysical Instrument Laboratory of The Superior Oil Company, South Pasadena, Calif., as an electronic research engineer. In this position, he was responsible for the design of low-frequency audio amplifiers and did extensive work with electromagnetic transducers. He retired in 1955. Mr. Johnson was a member of the Institute of Radio Engineers.

Arthur Calvin Burroway (AM '25, M '37), information manager, public relations, Cincinnati & Suburban Bell Telephone Company, died recently. Mr. Burroway was born in Canton, Ohio, on January 7, 1901. He recieved an electrical engineering degree in 1924 from the University of Cincinnati where he was elected to Tau Beta Pi and Eta Kappa Nu. He was employed as a co-operative student by the Cincinnati & Suburban Bell Telephone Company in 1920. He was appointed a junior engineer with that company in 1924. After holding various positions, he was made plant engineer in 1945. In 1954, he was appointed information manager in public relations. Mr. Burroway was very active in the Cincinnati Section of the Institute, serving on numerous committees, as secretary, and as president in 1937. In 1935, Mr. Burroway was a member of a committee whose work led to the organization of the Technical and Scientific Societies Council of Cincinnati. He served as president of the Council in 1937-38 and received the Council's "Engineer of the Year" Award in 1954. He was a member of the Engineering Society of Cincinnati.

Ronald Bowman Stewart (AM '23, M '51), staff engineer, Transmission Engineering Division, The Pacific Telephone and Telegraph Company of Los Angeles, Calif., died recently at the age of 61. Mr. Stewart was born in San Francisco, Calif. Following his graduation from the University of California at Berkeley in 1921, he joined The Pacific Telephone and Telegraph Company in San Francisco. In 1924, he transferred to the development and research department (now Bell Telephone Laboratories) of the American Telephone and Telegraph Company. In 1928, he transferred to Electrical Research Products, Inc. (a Bell System subsidiary) at Hollywood, Calif. In 1938, he returned to The Pacific Telephone and Telegraph Company at Los Angeles. He worked first on the Plant Technical Staff and later in the engineering department largely on exchange noise, crosstalk and related interference, and inductive co-ordination matters. During World War II, he worked for about two years on the development and application of Sonar as a means of submarine detection, under the auspices of the National Defense Research Council.

Phillips Thomas (AM '10, M '24, Member for Life), special representative, Westinghouse Electric Corporation, East Pittsburgh, Pa., died recently. He was 75 years old. Dr. Thomas was born in Granville, Ohio, on July 26, 1883. Holder of a Ph.D. in electronics from Princeton University, he was closely associated with Dr. Frank Conrad, builder of KDKA, the world's first commercial radio station. Dr. Thomas was the inventor of the ultra-audible and glow discharge microphones, long the standard instruments in the radio industry. The radio program "Adventures in Research," still originating at KDKA and broadcast to 100 stations, was started by Dr. Thomas and Paul Shannon, his associate. Dr. Thomas became associated with the Westinghouse Electric Corporation at an early age. He retired in 1946.

OF CURRENT INTEREST



ALPR control room showing (left to right) nuclear control panel, process panel, and generator control panel. The control room is located in the Support Facilities Building adjacent to the reactor.

3,000-Kw Gross Heat Produced by Portable Direct-Cycle Boiling Water Reactor

THE ALPR (Argonne Low-Power Reactor) is a direct-cycle boiling-water reactor of 3,000-kw gross reactor heat, with enriched uranium fuel; moderated and cooled by natural circulation of light (ordinary) water.

Reactor designed produces 200 kw of electricity and 400 kw of space heat. The power is intended to operate radar equipment and the heat is intended to warm offices, barracks, or other installations. This portable "package" power plant reactor is for use in remote areas.

The capital cost of such a main power source would exceed that of diesel plants currently serving the DEW Line, but diesel fuel shipping and handling costs are so high that the use of a reactor plant might be justified on economic grounds alone. For example, the cost of shipping fuel oil to an Arctic port, unloading it, delivering it inland by air, maintaining a landing strip, and providing terminal and intermediate storage facilities could result in a delivered fuel cost of $1.50 to $2 per gallon of diesel oil. And, sustaining a supply line to a remote Arctic base—difficult enough in peacetime—would become impossible in time of war. The prospect of fueling a plant for 2 or 3 years with a single fuel load weighing about 250 pounds was, therefore, very attractive.

The ALPR was designed and engineered at Argonne National Laboratory (ANL), Lemont, Ill.; Pioneer Engineering and Services, Chicago, Ill., did the mechanical and engineering design. The contractor for its construction at the National Reactor Testing Station (NRTS) in Idaho was Fegles Construction Co., Minneapolis, Minn.

Control room, associated laboratories, and shops are located in the Support Facilities Building adjacent to the ALPR. Building design can be altered to suit locale.

An aluminum–nickel alloy, *X-8001* developed by the ANL, was employed extensively in construction. The *X-8001* alloy was used to fabricate the entire reactor core with the exception of minor items.

The ALPR System

Saturated steam is generated in the ALPR pressure vessel at 300 pounds per square inch (psi) and 420 F. About 85% of the steam is used to generate power; the other 15% bypasses the turbine and is used for space heating. Steam generation rate is 9,020 pounds per hour, corresponding to a reactor heat output of about 3,000 kw. Although present boiling water reactors have operated on a steam bypass control principle (i.e., reactor power remaining constant), ALPR will soon incorporate a further control development that automatically adjusts power generation rate.

Water level is held constant in the pressure vessel by an integrating 3-element control system to insure steady operation and complete immersion of the reactor core.

Feedwater enters the reactor through a spray ring surrounding the core, flows down the circular annulus around the core, and mixes with downcoming water, making it slightly cooler than the rest of the core. This phenomenon, plus the lighter weight of the coolant in the steam-filled channels within the core, causes natural circulation of the water upward through the core. For every pound of steam produced, roughly 120 pounds of water are circulated through the reactor.

In the pressure vessel of the reactor 5 gallons of water per minute are continuously pumped through a purification system to maintain high purity (total solid concentration is expected to be less than 2 parts per million), which was designed by Illinois Water Treatment Company, Rockford, Ill.

The reactor has no vapor containment shell, inasmuch as future models of the reactor will be installed in remote areas.

If reactivity is increased in a boiling water reactor by withdrawing a control rod, the rate of heat generation increases until reactivity subtracted by steam bubbles (voids) exactly compensates for the reactivity added by withdrawal of the control rod. The negative reactivity effect of the voids occurs because the nuclear chain reaction depends on the

AIR-COOLED CONDENSER is located on wall side of the fan floor of the reactor.

presence of water moderator in the core. As the water boils, voids force moderating water out from between fuel plates and the voids provide an easier neutron leak path. This negative effect makes boiling water reactor control easier.

Design Safety

The fuel elements are aluminum–uranium alloy, clad with *X-8001*. They are completely welded and tested to assure that no radioactive materials can escape and that no water an enter to corrode the fuel. This cladding constitutes the first defense against release of radioactive material..

The second defense is the completely sealed, closed-cycle coolant system that includes the reactor's pressure vessel, piping, turbine, condenser, and storage tanks. This system can contain any radioactive material that might accidently be released from the fuel elements.

Designed into the system is a series of detectors and circuits that will shut down the reactor automatically. As an added precaution, some of the more vital circuits have standby duplicates.

Core elements will not be subject to a heat flux that will cause burnout because control rods can be inserted rapidly enough to shut down the reactor safely. Further secondary shutdown can be accomplished by injecting neutron-absorbing boric acid into the water.

FUEL PLATES for the ALPR are assembled in this rig. The fuel bearing alloy is shown pressed into its aluminum alloy "picture frame." The top aluminum alloy plate of the sandwich, coated with a fine layer of silicon, is about to be put in place.

The power densities at design operating conditions are only ⅛ those at which BORAX I could operate stably. The 16-foot-thick radiation shield can utilize material found in practically any location. The top layer of this gravel is coated with a nonpermeable emulsified tar to restrict leakage of radioactive gas or dust.

Below the reactor, a sheet of metal containing boron helps prevent activation of the air in the gravel voids by capturing and absorbing thermal neutrons coming through the reactor tank. The gravel also shields secondary systems that occasionally contain radioactive materials —for example, the water storage and clean-up system and fuel storage wells.

The building that houses the ALPR is a circular, continuous-welded steel tank, 38 feet 7 inches in diameter, extending 50 feet above grade. The tank serves as a weather shell around the structural steel framework that was erected inside the tank but independent of it. The building has 2 floors: the operating floor 19 feet 4 inches and the fan floor 32 feet above the tank bottom.

ALPR's pressure vessel is centrally located below the operating floor. Here also are three fuel storage wells, a reactor water retention tank, a purification vault, 2 storage sumps, and various instrument wells, ducts, and piping.

Access to the building is by way of an enclosed stairway, an emergency open stairway, and a cargo door in the tank wall, all leading to the operating floor. Access to the fan floor is through a hatch from below and an air lock. This floor contains the main air-cooled condenser with its fan, an air-mixing chamber, and ductwork. Condenser air is supplied and exhausted through an opening in the tank wall. An equipment hatch can be opened in the metal panel floor.

Pressure Vessel

The reactor vessel, built by Lasker Boiler Works, Chicago, Ill., is fabricated from firebox steel and stainless steel. The cover plate is stainless steel clad. It was designed for 400 psig at 450 F water and steam temperature with 500 F metal temperature. The bottom is elliptical; the top cover is flat and has nine 6-inch nozzles to accommodate control rod drives and two small nozzles for water-level indicating controls. These provide access to the core without removing the head.

The vessel has internal base pads to support a thermal shield which, in turn, supports the core structure. There are five connections through the wall of the vessel. Two of these lines lead to an upper and lower spray ring. The vessel is insulated with 3 inches of magnesia, surrounded by a protecting steel jacket.

The support cylinder, also furnishes radiation shielding—a 1¼-inch thick blanket of lead and copper cooling coils embedded in lead to remove gamma heat; all of it encased in a ¼-inch steel jacket. At core level, there is additional shielding in the form of a 1¼-inch thick steel band.

Steam Turbine and Generator. About 85% of the steam produced in the nuclear reactor is fed into a conventional steam turbine, coupled to a 300-kw electrical generator. Steam enters the turbine at 275 psi and somewhat less than 420 F and is exhausted to the air-cooled condenser at a vacuum corresponding to 4.85 inches of mercury. The turbine-generator for the ALPR was manufactured by the Worthington Corp., Wellsville, N.Y. Power is controlled and distributed by switchgear designed and built by the Nelson Electric Manufacturing Co., Tulsa, Okla. Emergency power supply equipment was designed and built by the Bogue Electric Manufacturing Co., Paterson, N.J.

Air-Cooled Steam Condenser and Feed Pumps. Steam condenser for the ALPR is cooled with air instead of the water used in conventional plants. The air is circulated over finned condenser tubes by a 90-inch fluid-drive 75-hp fan delivering an estimated 93,000 cubic feet per minute. Exhaust steam, condensing inside the air-cooled condenser tubes, is collected and returned to the reactor by conventional feed pumps. The special all-aluminum, air-cooled condenser was designed, developed, and fabricated by the Modine Manufacturing Co., Racine, Wis. The feed pumps were manufactured by Ingersoll-Rand Co., New York, N.Y.

Space Heating. In the reactor, 15% of the steam produced is available for space heating. In this prototype reactor the heat is dissipated through a hot water-to-air heat exchanger located outside the reactor.

Instrumentation and Control

In the control room, instruments and controls are segregated on a Process Control Panel and a Reactor Control Panel. Those panels, together with associated remote transmitters and control devices, were supplied by Leeds and Northrup Co., Philadelphia, Pa.

To avoid instabilities that might be caused by steam demand, a steam bypass system is employed, in which steam is bypassed to the condenser through two valves connected in parallel; they are controlled as a function of reactor steam pressure so that total bypass steam flow is proportional to pressure deviation from a set point.

To keep the air-cooled condenser from freezing when outside temperature is low (design minimum air temperature is —60 F), the temperature of condenser inlet air is regulated by recirculating a variable fraction of the total air flow through a mixing chamber. To implement this system, the average temperature detected by 12 thermocouples distributed across the inlet face of the condenser is fed to a temperature controller. This, in turn, controls damper drive motors on both air exhaust duct and mixing chamber. Design condenser air inlet temperature is 40 F.

When maximum condenser capacity is not required, a second group of 12 thermocouples senses the average temperature and condenser-fan speed is reduced. A second temperature controller utilizes the signal to regulate fan speed through control of a variable hydraulic coupling between the fan and its drive motor.

The drive system was designed and built by ALCO Products, Inc., Schenectady, New York.

Fuel element rupture is detected by a scintillation counter that monitors gamma activity of the air-ejector exhaust gas.

Rack and pinion control rod drives are coupled to drive motors through magnetic clutches and over-running mechanical clutches in parallel. Thus, interruption of power to the magnetic clutches causes the rods to fall into shutdown position, while the mechanical clutch provides positive drive-in.

Two-rod drive-control switches are on the operating panel. One switch controls the center rod drive only, the other may be connected by a selector switch to any one of the eight peripheral rod drives. Interlocking contacts prevent withdrawal of two rods simultaneously.

Nuclear Design of the Core

Design of the core was guided by three major considerations:

1. In light of favorable experimental work in BORAX I, II, and III, aluminum plate fuel elements were used, assembled into roughly 4- by 4-inch boxes. The fuel plate "meat" (fissionable portion) is aluminum alloyed with highly enriched uranium. One significant improvement is that some nickel was added (2 weight per cent) to increase alloy resistance to boiling water corrosion. A 0.035-inch layer of *X-8001* (1 weight per cent nickel) is expected to protect the meat during several years of anticipated core operation.

2. A second consideration was that the volume fraction of all the metal in the core should not be so small as to lead to a positive steam void coefficient, or so large as to lead to a large negative void coefficient and possibly to unstable reactor operation. For the cold reactor, a metal-to-water ratio equal to 0.5 was set (this being an intermediate value to the corresponding values of BORAX I and III. Subsequently, a coolant channel width of 0.31 inch was selected as a reasonable extrapolation from BORAX core design, together with a 0.050-inch meat thickness in the fuel plate. The reactivity produced by steam void is approximately 1.5% in the reference reactor operating at 3 mw (thermal).

3. The third consideration governing ALPR core design was that enough control rods or plates should be available in the form of rods or plates to control the reactor at all times throughout the core cycle. Five cross-rods were selected for the reference core, and provisions were made for four additional T-rods to be added if the reactor should be loaded to its maximum capacity of 59 fuel assemblies.

To reduce control requirements so that this control rod system would be adequate, consideration was given to the uniform dispersal of a burnable poison, boron 10, in the fuel meat. It proved difficult to fabricate well-bonded clad fuel plates incorporating a fixed amount of burnable poison. The choice fell instead to thin strips of aluminum–nickel alloy *X-8001* containing boron-10. These strips are welded to the fuel assembly side plates. It is anticipated that enough boron-10 will be incorporated to control approximately 10% of reactivity in the reactor. Reference core loading is now 14 kilograms U-235 in 40 fuel assemblies.

Fuel Assemblies

Each assembly, 34½ inches long by 3⅞ inches square, is composed of a locating fitting at the lower end, nine fuel plates, two side plates, and a top fitting equipped with a gripper pin for fuel-handling.

Top fitting consists of an extruded spider section welded at inside corners to an extruded rectangular section to form a unit. The spider section at top dead-center is drilled and tapped to take a corrosion resistant stainless steel gripper pin. A window machined out of each side of the rectangular section takes a stainless steel spring insert. The springs provide fuel element spacing and alignment and are riveted to the section. One large, oversize rivet is used to identify the side plate to which a boron-10 side strip has been attached.

Future Meetings of Other Societies

EEI, 3rd Annual Live Better Electrically Women's Conference, Jan 8-10, Edgewater Beach Hotel, Chicago, Ill. Anna Bines, Texas Electric Service Co, Fort Worth 1, Texas.

NACE, 15th Annual Conference & 1959 Corrosion Show, Mar 16-20, Sherman Hotel, Chicago, Ill. *Deadline for papers:* Jan. 9. T. J. Hull, NACE, 1061 M & M Bldg, Houston 2, Texas.

Building Research Institute, Conference on Noise Control in Buildings, Jan. 14-15, Hotel New Yorker, New York, N. Y. Harold Horowitz, BRI, 2101 Constitution Ave, Washington 25, D. C.

South West Electronic Exhibit, Jan 21-23, Arizona State Fairgrounds, Phoenix, Ariz. SWEE, 4353 W Missouri, Glendale, Ariz.

ASEE, Conference: "Industry Speaks Its Mind on Engineering Education," Jan 26-27, U of Houston, Houston, Texas.

10th Plant Maintenance & Engineering Show, Jan 26-29, Public Auditorium, Cleveland, Ohio. Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

IAS, 27th Annual Meeting, Jan 26-29, Hotel Astor, New York, N. Y. IAS, 2 E 64 St, New York 21, N. Y.

ASHAE, 64th Annual Meeting and 14th International Heating & Air-Conditioning Exposition, Jan 26-29, Convention Hall, Philadelphia, Pa. E. K. Stevens, International Exposition Co, 480 Lexington Ave, New York 17, N. Y.

5th Annual Radar Symposium, Jan 27-29, Willow Run Laboratories, University of Michigan, Ann Arbor, Mich. Security clearance through *Secret* required. Send to: Victor Scodius, security officer, U of M, Willow Run Labs, PO Box 2008, Ann Arbor, Mich.

SPE, 15th Annual Technical Conference, Jan 27-30, Hotel Commodore, New York, N. Y. W. C. Cleworth, 15th ANTEC, 342 Madison Ave, New York 17, N. Y.

5th Annual Midwest Welding Conference, Armour Research Foundation of IIT, joint AWS, Jan 28-29, IIT, Chicago, Ill. Harry Schwartzbart, ARF, 10 W 35 St, Chicago 16, Ill.

1st International Symposium on Nuclear Fuel Elements, Columbia Univ, joint Sylvania–Corning Nuclear Corp, Jan 28-29, Columbia U, New York, N. Y. W. J. Roach, Sylvania–Corning Nuclear Corp, Bayside, N. Y.

Symposium on Millimeter Waves, Microwave Research Institute, Polytechnic Institute of Brooklyn, joint AF Off of Sci Res, U. S. Army Sig R & D Lab, Off of Naval Res, IRE, Mar 31–Apr 2, PI of Brooklyn, Brooklyn, N. Y. Prof H. J. Carlin, MRI, 55 Johnson St, Brooklyn 1, N. Y. *Deadline for papers:* Jan 30.

ASTM, Committee Week, Feb 2-6, William Penn Hotel, Pittsburgh, Pa. ASTM, 1916 Race St, Philadelphia 3, Pa.

SPI, Reinforced Plastics Division, 14th Annual Technical & Management Conference, Feb 3-5, Edgewater Beach Hotel, Chicago, Ill. SPI, 250 Park Ave, New York, N. Y.

National Electrical Week, Feb 8-14. The National Electrical Week Committee, 290 Madison Ave, New York 17, N. Y.

AIME, Annual Meeting, Feb. 15-19, Hotels St. Francis, Sheraton-Palace, Sir Francis Drake, San Francisco, Calif. AIME, 29 W 39 St, New York 18, N. Y.

AES, West Coast Convention, Feb 17-20, Biltmore Hotel, Los Angeles, Calif. AES, PO Box 12, Old Chelsea Station, New York 11, N. Y.

NSPE, Winter Meeting, Feb 19-21, Dinkler-Tutwiler Hotel, Birmingham, Ala. NSPE, 2029 K St, NW, Washington 6, D. C.

Overseas

8th Electrical Engineers' Exhibition, Mar 17-21, Earls Court, London, England. Electrical Engineers Exhibition Ltd, Assoc of Supedvising Electrical Engineers, 6 Muscum House, 25 Museum St, London, WC 1, England.

Electrostatic Recording Device Prints 3,000 Wpm a Line at a Time

A TELETYPWRITER, at 3,000 wpm the fastest general-purpose message printer in communications history, was announced recently by the Department of the Army.

The revolutionary device, displayed in New York, N. Y., was developed jointly by the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J., and the Burroughs Corporation, Paoli, Pa. It prints four full lines of text a second—50 times faster than a news service teletypewriter, 45 times faster than an average typist, and 20 times faster than most people can talk.

But even at this high speed the new machine is operating in low gear. With further development, the theoretical top speed of its all-electronic page-printing system reaches the phenomenal 500,000 words a minute, at which speed it could type 3 full-sized novels in a minute.

Operating at a lower speed of 750 words a minute for Army Signal Corps requirements, the new electronic messenger will do the work of eight of today's military printers, promising substantial savings in personnel and equipment. It also gets completed messages to their destination eight times faster.

It will be the major unit in the Army's new family of teletypewriter devices, all operating at 750 words a minute. To-

THIS SAMPLE

SUPER-SPEED

PRINTER.

REPRODUCTION of the beginning of three lines set by the superspeed teleprinter. Letters are shown double actual dimensions.

gether they make up the fastest known military teletypewriter network, providing the increased message speed vital for modern atomic-age maneuvers.

This major breakthrough in ultrahigh-speed military communications is expected to have broad civilian applications. A standard teletypewriter—commonly seen clattering away behind a television news commentator or providing background noise in a newspaper office—is an automatic typewriter that responds to electrical signals. Linked by radio or telephone lines, it can print at 60 words a minute messages sent from distant stations.

Operation

The new Army teletypewriter has no ordinary keys. At 750 words a minute, they could barely get into the air or would jam up on the first word. Instead, letters are shot at the paper electronically by a bank of electrode "guns." The process utilizes a controlled source of electricity to form small charged areas on a high-resistivity surface such as a coated paper.

The electrostatic latent image formed by the charged areas is made visible by application of powdered ink, permanently fixed by the application of heat. After the volley of letters, each line of text passes rapidly over the powdered ink and heated roller, and appears a split second later as clear, readable text.

The recording head comprises 35 tiny wires leading into and through a triangular-shaped piece of plastic. The wires are polished flush with one corner of the triangle, or printing head, to form a rectangle seven wires high by five wires wide.

This is the matrix—72 of them in a row to form a printing line. They do not touch the paper but are maintained at a fixed distance from the paper surface.

Electric pulses will selectively charge all 35 wires or any combination of those wires in each head. A normal line of type, such as appears on a typewritten page, is made possible by setting up the first character in the line across all 72 heads. The only head that prints is the one selected by a coincident pulse to the back plate, or "anvil." The electrostatic charge can be deposited in one millionth of a second.

The second character in the word would be set up across the line and printed serially in a similar manner. Obviously, a line of 72 characters wide would require only a small fraction of a second.

During the recording stage, the electrical discharge from the printing head to a metal plate—grounded or of polarity opposite that of the printing head—is used as the source of charge to form the electrostatic latent image on the paper surface.

The size of the image depends mainly upon the polarity, the electric field strength and the surface coating on the paper. A relatively low negative voltage applied to the point electrode gives small, round dots.

Advantages

Features of the technique are:

High speed. A mark can be put on paper in a duration as small as one microsecond (one millionth of a second) and printed characters formed by a five-by-seven dot matrix have actually been recorded at rates of 1,050,000 dots per second. This means that it could produce plain language messages at speeds of several hundred thousand words per minute. The only limitation is the speed at which paper can be handled.

Highly reliable. By going directly from electronic impulses to static charges on the final usable copy, many intermediate steps are eliminated. This results in a high order of reliability, absence of errors, and low maintenance cost.

Limited motion. The only mechanical motion involved in the technique is the handling of the continuously moving paper under the printing head. No wear of the pin electrodes or the like is involved, inasmuch as they never touch the paper itself but merely send a charge through the paper from the pin to the grounded metal plate (anvil).

Inexpensive. The system is basically low in cost and consumes very little power. The power required to print 5,000 characters per second, serially, is about 5 watts in addition to that necessary to move the paper and fix the recorded images. The paper is a little more expensive than ordinary writing paper.

Practically noiseless. It is relatively quiet; the only noise is caused by the moving paper. No mechanical hammer action is involved.

Clean. The printing does not involve any messy, wet or damp processes. An immediate hard, dry, readable copy is obtained on odorless, nontoxic paper.

Permanent. Permanent recording with no fading is achieved. By eliminating the inking and fixing steps, the paper can be erased and used over again or can be "read" electronically by picking up the electrostatic charge.

The ink consists of a single powder without electric charge. To ink the latent image on the paper's surface, the paper is passed through an inker containing the dry powder to give a visible image.

The image is made permanently visible by passing the inked paper over a temperature-controlled hot plate. The three steps in the process are consecutive and are performed as the paper moves at the appropriate speed for the particular recording application.

Other Applications

The high pulsing rates made possible by this printing technique allow reasonably high recording speeds to be obtained in a small-sized, low-powered, low-cost recording device.

The machine operates from standard code tape, or can be plugged into long-distance radio or telephone circuits to print out messages sent from across the continent or overseas.

Applications for the electrostatic recording device can be readily visualized for labeling or strip-printing, digital computer output systems, page-printers and plotters, teletypewriting and telemetering, high-speed strip charting, and facsimile printing.

Burroughs Corporation and U. S. Army Photograph

3,000 WORDS A MINUTE is spewed out by new Army teleprinter on six feet of paper. Operated at Message Center by Lt. Arnold Clum of Humboldt, Kans., the revolutionary device is the world's fastest general-purpose message printer.

IGY and Space Flight Information

Higher, Faster, Farther Missile. Existence of a new supersonic air-to-air guided missile which climbs higher, flies faster, and has a greater range than any of its predecessors, was announced recently by the U.S. Air Force and Hughes Aircraft Company, its developer and producer. Fourth in the family of *Falcon* missiles produced by the company, the new *GAR-3* (guided air rocket) is scheduled to go into operational service as principal firepower of advanced all-weather jet interceptors of the Air Defense Command. One of the principal differences between the new *Falcon* and other models is a distinctive white ceramic nose cone, longer, and more pointed than the stubby, rounded radomes of earlier "birds." According to company engineers, the nose cone represents a significant development of a material capable of withstanding a great variety of environments created by both speed and temperature and enables the *Falcon* to adjust to these environments in fractions of seconds. Other external changes in the *GAR-3* include its greater length (slightly over 7 feet), increased wing span, an extension of stabilizers so that they reach beyond the center of the airframe.

Fluorine for Space Flight. A chemical so flammable it will ignite asbestos, leather, and even water on contact has been harnessed for space flight rocket propulsion by engineers of Bell Aircraft Corporation. The chemical is elemental liquid fluorine, the most powerful of all known oxidizing agents, which is recognized as the pinnacle in liquid rocket oxidizers. It has been disclosed, with authorization of the U.S. Air Force, that Bell Aircraft's Rockets Division has accomplished the first large-scale rocket thrust chamber firings utilizing liquid fluorine, considered to be the last major breakthrough in chemical rockets. Research and development work which led to the successful firings was closely co-ordinated with the Power Plant Laboratory of the Air Force Wright Air Development Center, in Dayton, Ohio, which is sponsoring the work. Significance of the fluorine application to rocket propulsion is that payload increases up to 70% can be achieved with existing ballistic missiles and space vehicles now on the drawing board. Fluorine can be combined with existing fuels to produce propellant combinations capable of increasing from 22 to 40% the power output of today's rocket engines. This increased efficiency will allow a tremendous reduction in size and weight of rocket-powered missiles of the future without sacrificing performance.

Pioneer's "Priceless Information." Britain's giant radiotelescope at Jodrell Bank in Cheshire, England—the largest steerable radiotelescope in the free world *(Electrical Engineering,* Sept. 1957, pp. 819-20)—received priceless information from the American moon rocket Pioneer fired from Cape Canaveral on October 11, 1958, by the U.S. Air Force. Prof. A.G.B. Lovell, director of the astronomy station, reported that "for the first time, we have had 2 full days of information about conditions in space up to 80,000 miles—regions which no man-made objects have ever penetrated before." No fewer than 112 "fixes" of the rocket's positions—all of them accurate to within one-fifth of a degree—went from Jodrell Bank to the United States. Signals from the rocket, first picked up by Jodrell Bank 10 minutes after firing, were very strong from the start, and the station has never had such powerful signals before. So far as the telescope is concerned, it was said that it has been "a piece of cake" (R.A.F. language for "like falling off a log"). Radio information giving instrument readings of temperatures, meteorite impacts, and ion content in space was received by the radio telescope in the form of coded signals. There was no interference and Jodrell Bank could see quite clearly on a chart the rotation of the rocket—about 110 revolutions a minute. These signals were piped from the collecting aerial at the focus of the telescope bowl to a U.S. Air Force mobile equipment van manned by United States scientists, near the control building. All the information from the Pioneer was relayed from the telescope via two telephone and a teletype line in the trailer through to the United States. W.D. Young of the American team paid tribute to "a wonderful crew" at Jodrell Bank where the men had not only co-operated in a great many ways, but also had gone "above and beyond the absolute requirements."

Information on the X-15. A 400-mile-long test range stretching from Edwards Air Force Base to Ely, Nev., is being readied by the Electronic Engineering Company of California, Santa Ana, Calif., for the testing of the North American Aviation *X-15* rocket powered test vehicle. The range, located over the wastelands of Nevada, consists of radar, telemetering, data handling, and special communications equipment which will enable test-range operating personnel to guide the manned space ship back to earth safely after a flight high above the earth. Officials stated that the *X-15* program is expected to provide answers to actual flight conditions beyond the earth's atmosphere and also to increase knowledge of aerodynamic heating and heat transfer, including heat measurements on 600 points of the *X-15's* structure. North American Aviation officials and Air Force and Navy personnel say that it will also provide answers on control requirements in the near vacuum found at extremely high altitudes, plus the effectiveness of the *X-15's* unique two-control system—primary aerodynamic flight controls, and ballistic controls during research flights. The *X-15* rocket engine uses liquid oxygen and liquid ammonia as propellants, with a consumption rate of some 20 times that for conventional jet-fighter engines. Thiokol's Reaction Motors Division will supply a rocket engine, the *XLR-99,* of 50,000 pounds of thrust. Two *XLR-11* interim rocket engines of less thrust will be used on the initial *X-15* powered flights. The *XLR-11* engine was utilized in the *X-1* research airplane program. The landing-gear arrangement includes a dual nosewheel and steel skids. One of the most advanced airborne flight data systems ever developed—an extremely precise inertial system—is being readied on schedule by the Sperry Gyroscope Company at Great Neck, N.Y., for manned probes of space by the hypersonic *X-15.* The unique equipment will direct the pilot from the instant of launch through the high-velocity acceleration phase of the *X-15* mission and provide data enabling him to control the research craft during the critical period of re-entry into the

GAR-3 (left) is displayed by test pilot T. V. Smith of Hughes Aircraft Company in comparison to GAR-1D (right) one of the first Falcons. The longer, higher, and deadlier reach of the new air-to-air guided missile is powered by a new longer-lived solid propellant rocket engine.

earth's atmosphere. Heart of the Sperry inertial system is a compact, three-gyro stable "platform" which will provide critical attitude, velocity, distance, and altitude sensing. The platform, which incorporates outstanding advances in electronic miniaturization, contains all its own power supplies and amplifiers. A lightweight computer digests and interprets this data and displays it pictorially for the pilot on specially developed cockpit instruments. Despite the small size and low weight of the system, it meets rigorous specifications of ruggedness and reliability. Each component is able to withstand accelerations of more than 10 g's (10 times the force of gravity). In addition to providing inertial information, the system's sensors and computer will feed data to specialized airborne and ground-based recorders for permanent charting of each flight. The *X-15* system is designed to accept exact velocity signals from a Doppler navigation system in the *B-52* "mother plane" until the moment of launch and thereafter to function as a pure inertial system—completely without outside aid. The Air Force and the National Aeronautics and Space Administration announced that when the high-powered *X-15* rockets into space, it will carry along its own atmosphere in the form of liquid nitrogen in a significantly advanced pressurization and air-conditioning system for the pilot and vital equipment. Produced by The Garrett Corporation's AiResearch Manufacturing Division, Los Angeles, Calif., the nitrogen system is a radical departure from normal pressurization and cooling procedures using air surrounding an aircraft. Liquid nitrogen, contained at approximately –300 F, will take over on the *X-15*. It will be used in vital areas to maintain adequate environmental pressure and to act as a cooling deterrent to excessive temperatures and the relative ease of maintaining it in a liquid state (doesn't easily vaporize) makes for ease in handling. Pressurized helium gas is used to expel the nitrogen. The helium is contained in a spherical chamber at 4,000 psi pressure. Before being applied to its task, the gas flows through a regulator and is reduced to an operating pressure of 70 psi.

The first man to soar into the fringes of space aboard the *X-15* manned research vehicle will depend upon an instrument being built at the Grand Rapids Division of Lear, Incorporated, for precise information to help keep him on his pre-arranged flight path. The instrument a specially designed three-axis indicator showing altitude of the *X-15* in relation to the earth, will guide the pilot during the critical periods of the flight when the faster-than-a-bullet craft exits and re-enters the earth's atmosphere. Asked by the Wright Air Development Center (WADC) to supply a three-axis Flight Director–Attitude Indicator for installation in the *X-15* designed and built by North American Aviation, an Air Force, National Aeronautics and Space Administration, and the Navy jointly sponsored project, the company supplied a modified version of the Lear Model *4060* (A.S.T.R.A.) indicator. As the craft returns from the void of space into the earth's atmosphere, it will hit a veritable "wall" of air. To assure that the longitudinal axis of his craft is perfectly aligned with its flight path, the pilot will rely on the attitude sphere and flight path pointers in the Lear indicator. A pictorial-type sphere gives the pilot the attitude of his aircraft with respect to earth in terms of pitch, roll, and yaw. A vertical needle shows the side slip of the aircraft, and a horizontal pointer indicates angle of attack. Yaw and pitch angles reveal the displacement between the direction in which the aircraft is pointed and the direction in which it is moving. The company will also supply a rate gyro from which the turn indicator gets its reference, a director control box which feeds the pilot's commands to the vertical and horizontal needles, and a pitch angle set control—a separate black box which allows the pilot to preselect a pitch angle command display at which he wants to fly.

Outer Space Study Photographic Scientists' Challenge. The study of space is the new challenge for photographic scientists—simply because space is there and man's insatiable curiosity will drive him to explore it. And much of the information about outer space will be obtained by photography. Just as the camera has been the astronomer's indispensable tool, so it will be the primary tool of the space scientist. How will the orbiting rockets give the information they are sent to gather was asked. It was noted that there was no likelihood of a directly produced, sharply detailed television image because of the high resolution required. But photography guarantees a satisfactory solution. Scientists are finding out what difficulties might be caused by cosmic rays or other radiation in such space-photography. The current plans to study the spectra of Mars from a high-flying balloon 100,000 feet above the earth are expected to expand knowledge about the atmosphere of Mars and especially about its water content. "Surely," stated an Eastman Kodak (EK) executive, "these efforts foretell the day when men will visit this provocative neighbor of ours . . . You and I may not live to see his triumph, but we'd better get busy with our preliminary assignments all the same. Keep in mind all the celestial reconnoitering by photography that must be done in advance." Donald McMaster, vice-president and general manager of EK, also spoke of varied uses of photography in study of the sun, in nuclear physics, and in electronic computing systems.

To the Sun via Moon. A rocket to the sun with an assist from the moon was suggested recently by R. P. Haviland, nationally prominent satellite engineer with the General Electric (GE) Company. Calling for an extension of the IGY, Mr. Haviland stated that probes of the solar atmosphere should be a project for extended IGY activities. This "stepping-stone" trip to the sun would be made possible, according to Mr. Haviland, by the "crack-the-whip" effect of centrifugal

SCOTT CROSSFIELD, veteran rocket pilot, boarding an F-100 has been chosen to prepare himself for flying the X-15. In event of emergency, the entire cockpit becomes an escape capsule. Space suit is worn (right) in event that cabin loses pressure. Gadget near his mouth is a communications device. Lear model 40608 flight director–attitude indicator (above) will give pilot of X-15 his reference to earth.

force generated by the moon in its orbit around earth. The probe vehicle would be guided near enough to the moon to take advantage of the speed—about 3,600 miles per hour—it could borrow from the moon during the moon's orbital journey around the earth. Added to the speed, the vehicle has already achieved during its "escape" from the earth's atmosphere, the boost from the moon would serve the same purpose as a tailwind for an aircraft. Under the present state of the art, 50-pound probes could be sent as far as the planet Mercury using 5-stage vehicles with 250,000-pound take-off weights. "Closer approaches would require additional stages or additional take-off weights, both of which are impractical at this time," Mr. Haviland stated.

Moon Power Station. Elements of an electric power station designed for use on the moon have been demonstrated by scientists of the Westinghouse Electric Corporation. A working model of the moon power station was operated to show how the revolutionary generating unit would be powered by light from the sun. A modified vacuum tube, containing the same elements that would be used in a full-scale station on the moon, absorbed a beam of light from a nearby sunlamp generating enough power to drive a small motor. The importance of the lunar electric power plant project is dictated by the fact that a United States space base on the moon must, first of all, be self-sufficient. Basic components of the actual power station consists only of wire mesh and a chemically coated plastic. Giant sheets of a thin plastic material will be stretched and supported over several acres of the moon's surface. Coated on these sheets will be an extremely thin layer (about one micron thick) of a photosensitive material. A thin wire mesh will then be placed parallel to, but slightly separated from the plastic sheet and insulated from it. The photoelectric generator would then be ready to produce electric power. As the sun's rays strike the plastic sheet, the coated surface will emit electrons. These electrons will strike the wire mesh generating a voltage. Upon closing the circuit between the wire grid and the coated surface through a suitable load, current will flow. This type of electric power plant is the lightest known to man. The total weight of required material would amount to about 3 pounds per kw. As to solar conversion efficiencies, it was quickly pointed out that insight gained into the photoelectric phenomenon now shows promise of generators having up to 25% efficiency. This compares with about 35% for the conventional earthbound generating station. Achievement of this 25% would mean power yields of about 1,500 kw per acre on the Moon with the Sun at zenith.

Automatic Aircraft Landing System. Application of newly developed "calibrated prediction" techniques promises substantial improvement in automatic landing systems for aircraft, missiles, and space vehicles, E. R. Buxton, flight control system engineering group leader with Autonetics, a Division of North American Aviation, Inc., asserted at a recent SAE National Aeronautical Meeting in Los Angeles. With the new servo-design technique, the way is paved to take full advantage of the sensing instruments and computer system in the design of an optimum flare computer capable of providing a fully automatic and manual-blind landings in a large variety of aircraft, Buxton said. Careful studies of pilot-controlled landings indicate that the pilot uses prediction and learns servo techniques during the landing process by applying a pulse-type of control to the "stick," the Autonetics' engineer said. In essence, "calibrated prediction" is accomplished by a computer that receives information from such sensing instruments as gyros, accelerometers, and a radar altimeter. "In the landing operation," Buxton explained, "the computer knows what the plane is doing and what action will result, just as a human pilot knows what will happen to his landing path, course, and other control motions when he operates the 'stick.' The computer continuously measures actual actions and reflects conditions that will prevail at touchdown." Amplifying this, he explained that when a piloted plane hits an air-bump during landing, the pilots aims for the same touchdown point. If disturbed during flare-out, a new mathematical path is promptly computed so that the aiming point is still reached at touchdown time—on a steeper, or shallower, glide—and a uniformly "soft" landing is guaranteed under any disturbing conditions. To commercial airlines the automatic all-weather landing equipment would increase flight safety, reduce visibility minimums to near zero, and save several million dollars lost annually because of bad-weather flight cancellations. It also would make possible increased drone and research vehicle performance, he said, through use of low-fuel-consumption approach angles, increased recovery, and elimination of chase-plane control.

Doppler Systems. Greater navigational accuracy for supersonic aircraft resulting from integration of inertial and Doppler radar navigational systems was described by Dr. D. B. Duncan at a National Electronics Conference technical session. Dr. Duncan, manager of Advanced Engineering at Autonetics, a Division of North American Aviation, Inc., said the combination system can be particularly effective in large aircraft where such a system would have the needed space. Doppler navigation makes use of a shift in frequency of reflected radar signals observed when the transmitter receiver is in motion relative to the reflecting surface. Inertial navigation, based on Newton laws of motion, requires no outside reference. Greater accuracy is obtaned, Dr. Duncan said, by comparing the inertial velocity against the Doppler velocity. If there is an error, the comparison will find it and signal for automatic correction.

Vanguard I Sets Record. Vanguard I's radio transmitter, powered by sun energy, extended its record for operating in orbit to 7 months on October 17, 1958. The milestone for power generation in outer space was reported by Dr. M. B. Prince, vice president—research, Semiconductor Division, Hoffman Electronics Corp., makers of silicon solar cells that convert sunlight into electricity to power the radio. He said that barring impact with meteorites or cosmic dust, the solar energy converter has a life expectancy of up to 10,000 years. Estimated Vanguard life is 200 years. Cessation of signals from Explorer IV, reported recently, now leaves only Vanguard I and Sputnik III reporting to Earth from outer space. It is reported that Sputnik's transmitter is also powered by solar energy. Vanguard has 6 solar cell assemblies, each with 18 cells, distributed over its skin so that one assembly is always facing the sun.

DEMONSTRATION model of the moon power station.

Protons Guided by Magnets in Synchrotron

Unusually uniform electrical grade steel has helped make possible a new concept in smashing the atom, and will make possible the gathering of much more information on these basic building blocks of the universe. The new concept, called strong focusing, depends on huge magnets holding protons on course and using these particles to hit and break the nuclei of other atoms. The nuclear properties can then be observed and studied. For this purpose, a mammoth new proton synchrotron is being built at Brookhaven National Laboratory, Upton, N. Y.

The Brookhaven synchrotron will accelerate protons until they have up to 25 or 30 billion volts of energy. The higher the energy of the particles, the faster they travel and the greater the possibility of "breaking" the nucleus and uncovering new facts about atomic structures.

The process of strong focusing is made possible with specially designed magnets that are alternately bowed out and in like large letter C's. The magnetic force created by the magnets keeps the accelerating protons on course during the energy build-up period. The material for these large magnets was made by Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. More than 3,800 tons of electrical grade steel were required.

Unusually exacting requirements and records were made on all "batches" of this steel, as well as in the fabrication of the huge 7-foot magnets, made by the Baldwin-Lima-Hamilton Corporation of Philadelphia, Pa. Each of the 240 magnets had to be nearly identical in properties—commercial standards were rejected. The variations in magnetic properties in steel were taken into account, and special devices and techniques were devised by Brookhaven personnel to compensate for any minor distortion of the magnetic field prior to installation of the big magnets. The magnet cores were fabricated by building up laminations of steel (0.031 inch thick) which were stamped on a 450-ton press to proper pole configuration and outside dimensions of 33 inches by 39 inches. These cores, in two sizes (or thickness 75 inches and 90 inches) were strapped and welded under pressure to achieve an extremely high lamination factor—ratio of steel to air along core axis—of 98%. The 90-inch thick magnets, weigh 15½ tons each.

The heart of the synchrotron is the combination of 240 magnets arranged in a circle more than a half-mile in circumference, inside which is placed a vacuum chamber 7 inches in diameter and 3⅜ inches high. The giant magnets will develop enormous magnetic force of 10,000 to 13,000 gauss, and will be buried in a giant subterranean cement tunnel, 17 feet 9 inches high and 18 feet wide. The tunnel will be covered with 12 feet of earth.

The vacuum chamber, which is located in the jaws of the C of the magnets, will contain a clear aperture 2⅜ inches high and 6 inches wide. It is through this narrow aperature that a beam of protons will be made to travel as they are accelerated to tremendous energies.

Before the protons go into the synchrotron, their energy is first raised in a high-voltage generator to 750,000 electron volts. From here, they go into a linear accelerator and by stages are raised to an energy of 50 million electron volts. At this stage they are injected into the half-mile track to whirl around. Each time they go around the track, 12 radio-frequency accelerating stations give them additional boosts in energy so that at the end of their travels—one second, in which they have gone around the half-mile track some 350,000 times—they are traveling with an energy of 25- to 30-billion electron volts, and at a velocity approaching the speed of light.

At precisely this moment, the proton hits the nucleus of an atom and "breaks" it so that protons and neutrons are released. In addition, a variety of mesons will also be created. The meson is a mysterious particle, and is believed to be a special cosmic cement that holds the parts of the atom together. (*Electrical Engineering*, July 1958, p. 659.) Once this is done, Brookhaven scientists hope to be able to observe through various ways what happens and what the forces are which really hold the nucleus together.

GIANT MAGNETS, shown in photograph, are to be used in huge new synchrotron at Brookhaven National Laboratory. Magnets made possible a new concept of smashing the atom, called strong focusing, in which protons are held on course to hit and break other atoms.

Manpower to Nuclear Power

Times have changed. We haven't reached the moon as yet, but made a very good attempt to touch its orbit on October 11. In 1948, few persons gave any serious thought to the possibility of extra-terrestrial travel, and certainly if anyone approached any of the established foundations for a grant to finance a trip to the moon, he would have been unceremoniously shown to the door—if not locked up as strictly unreliable in character.

However, for three generations the Hill family of Saint Paul, Minn., has backed the development of all forms of transportation—land, sea, and air. Now, believing that it is in the best interests of humanity to recognize and to encourage significant contributions indicative of American enterprise and ingenuity in the art and science of space flight, the Hill Family Foundation has established the Louis W. Hill Space Transportation Award.

The Award, to be administered annually by the Institute of Aeronautical Sciences, is to take the form of an honorarium of $5,000 to an individual or, in the event of a "team" contribution, up to $10,000 to encourage space transportation for peaceful purposes.

The Award not only constitutes the largest monetary award for scientific achievement available through any scientific society, but also takes cognizance of the fact that IAS has a leading interest in the ever-broadening areas of space science and space technology. To those who make major contributions to the science and art of space transportation, this Award will provide tangible evidence of outstanding achievement.

United Nations Information Available

The Press and Publications Division of the United Nations Office of Public Information issues certain information media releases which are available to the public, but which are noted to be "not an official record." These press releases can be obtained at United Nations, N.Y.

Number	*Title*
AC/355	UN Atomic Conference Informed of Experiences with Separating U-235
AC/356	Progress in Fundamental Physics Reported to Atomic Conference
AC/357	World-Wide Use of Radioisotopes in Medicine Termed "One of Brightest Developments of Modern Science"
AC/358	Need for Continued International Collaboration Stressed at Geneva Atomic Conference
AC/360	Atomic Conference Told of Dangers of Depositing Radioactive Wastes in Oceans
AC/361	Nuclear Power Industry Not To Be Deterred by Waste Disposal Problems; Use of Isotopes in Agriculture Discussed at Atomic Conference
AC/362	Methods for Disposing of Low-Level Radioactive Wastes Discussed at Session of UN Atomic Conference in Geneva
AC/364-A	Round-up of the 2nd United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1-13 September 1958
EC/1859	Exploratory Meeting on Copper Convenes in London
EC/1861	Communique Issued by UN Meeting on Nonferrous Metals, London, September 1958
EC/1863	Industrial Growth in Eastern Europe and the Soviet Union, Expansion Noted in ECE's "Economic Bulletin"
IAEA/110	General Conference of Atomic Energy Agency Opens Second Session

Those persons interested in any of the topics covered should write for the release by number directly from the U.N.

Distribution of Radioisotope Standards

Effective as of September 18, 1958, the National Bureau of Standards (NBS) has discontinued the distribution of radioactivity standard samples of longer-lived radioisotopes which are now commercially available.

NBS Long-Lived Standard Samples

Number	Name
4910	Radium D + Radium E
4911	Radium D + Radium E
4912	Radium D + Radium E
4913	Cobalt-60
4914	Cobalt-60
4915	Cobalt-60
4919	Strontium-90/Yttrium-90
4920	Thallium-204
4928	Sulphur-35
4931	Cesium-137/Barium-137
4934	Tantalum-182
4936	Iron-59

Standardized samples of these nuclides may be obtained from the Nuclear-Chicago Corporation, 223 W. Erie St., Chicago 10, Ill. The standards issued by this firm are derived from comparisons made with the national standards maintained by the NBS. The firm, however, accepts full responsibility for the standardization of the samples that it distributes.

Discontinuance of this activity will permit the NBS to devote more of its resources toward meeting the demands of science and industry for new and more accurate standards. This action is in line with the Federal Government's general policy of withdrawing from activities that can be carried on by private business. The NBS will, however, continue to maintain the primary disintegration-rate standards of these nuclides. It is anticipated that there will be no interruption in the distribution schedules of the listed standards.

In May 1957, the NBS discontinued the distribution of five short-lived radioisotope standards.

NBS Short-Lived Standard Samples

Number	Name
4916	Phosphorus-32
4917	Iodine-131
4918	Gold-198
4923	Sodium-24
4933	Potassium-42

These nuclides also are available from Nuclear-Chicago.

Editor for IAS Publication Is Named

The Institute of Aeronautical Sciences (IAS) recently announced the appointment of Allan Bernhardt as editor of its *Aero/Space Engineering* magazine. He was formerly associate editor and succeeds W. A. Shrader, who will devote his full time to the duties of director of all IAS publications.

Aero/Space Engineering is the official monthly technical magazine of the IAS–representative professional society in the United States for engineers and scientists in all areas bearing on aeronautics and space technology.

Components Readied for Belgian Power Reactor

Components for Belgium's first atomic power reactor are moving toward completion at several plants of the Westinghouse Electric Corporation, Pittsburgh, Pa. The atomic power plant, which is rated at 11,500 kilowatts, is scheduled for operation late in 1959 at Mol near Brussels.

In preparing the fuel elements for the power plant, uranium oxide pellets are loaded into stainless steel tubes approximately 4 feet in length—90 pellets sealed inside each tube. The core of the nuclear power reactor will consist of 32 tube bundles, each with a total of 132 tubes, bringing together a critical mass of more than 557,000 pellets.

Among the components being built for the reactor are two canned motor-pumps and a heat exchanger. The motor-pumps, each rated at 300 hp, will circulate 6,250 gallons of water per minute through the primary loop of the reactor to extract its heat. The pumped fluid fills the motor cavity, but is excluded from the rotor and stator windings because both the rotating and stationary parts of the pump are "canned" in corrosion-resistant jackets. The cooling coils keep motor temperatures at satisfactory operating levels.

Steam from the heat exchanger will spin the turbine generator of the power plant. It will carry within its tubes pressurized water which has been heated to a high temperature by the uranium fuel in the reactor. A secondary flow of water passing around the outside of the tubes will absorb this heat and provide the steam for the turbine.

A progress report on the Belgium power plant was among the topics featured at the 2nd United Nations International Conference on the Peaceful Uses of Atomic Energy, held in Geneva in September 1958.

B-58 Guided by Missile-Like Controls

Augmenting the country's defense, the "missile with men in it"–the U.S. Air Force's unconventional *B-58* supersonic bomber—will be guided by automatic, missile-type inertial controls as sensitive and precise as those required for the longest-range ballistic missiles, it has been revealed.

The newly developed inertial guidance "platforms" for the stratospheric Hustler now are achieving test-flight accuracies expected, according to the announcement, indicating a rapid technological advance in gyroscopics and navigation systems. The systems were developed and now are being mass-produced by the Sperry Gyroscope Co. under contract with the Convair Division of General Dynamics Corp., Hustler weapon system manager. Unlike a conventional long-range missile, the controlled *B-58* can be flown by its "inertial" navigation system for hours. Hustler's Doppler–inertial Primary Navigation System, the *ASQ-42*, automatically and precisely navigates the *B-58* anywhere over the globe and automatically controls pinpoint release of the plane's 50-foot disposable "pod."

The primary source of navigational and altitude data for the *B-58*, the *ASQ-42* prime navigation system also supplies precise information to nearly a dozen other *B-58* subsystems, such as reconnaissance, flight control, etc. Hustler's primary bombing–navigation system is reported to be 10 times as accurate as operational systems, requires 37% less space, and weighs 20% less than systems that have much less versatility and much less reliability.

"Pushbutton World:" Thoughts and Developments

The old problem of man versus the machine, immortalized by the epic steel-driving of one John Henry, is today seen in the speculations, controversies, and inventions surrounding automation. The question sometimes seems to be: Is man really necessary? Can the machine "do it all?" From the University of Michigan, Ann Arbor, comes heartening news—for man's side. Don't expect too many pushbuttons in tomorrow's world, says Prof. P. M. Fitts, specialist on man–machine systems. Although more of man's work will become automated in the future, he continues, the combination of men and machines is more economical, efficient, and safe than either one alone in many complex tasks. Are we—man and his mechanical competitor—to achieve, then, a harmonious coexistence?

Dr. Fitts bases his conclusions on several years' work designing improved systems for air traffic control, which he conducted at the Ohio State University (OSU). Now on the U of M staff, he outlined some of his general findings at a recent psychology colloquium, as follows: (1) Man can do a good job of monitoring machines, provided he is given the information needed for decision making; (2) man is very good at making "iterative decisions," a process in which each decision leads to a more specific choice, but (3) one of his most serious limitations is his "immediate memory load," the amount of detailed information that he can carry around in his head and use almost instantaneously in decision making; (4) productivity of a man–machine system can be increased by adding more manpower, but "two men don't do twice the work of one" when this happens.

Dr. Fitts has spent the past five years running groups of pilots and air traffic controllers through OSU's air traffic control simulation. His research, supported by the USAF, will result in major changes in air traffic control over the next 5 to 10 years.

The over-all performance of an air traffic control system, Dr. Fitts maintains, can be increased with additional man-

power. But the need to co-ordinate activities when more than one person operates a system means that gains in performance are proportionately less than the increase in manpower. On the other hand, it may result in better performance over sustained periods of time.

What if the system breaks down? Man can handle emergencies well, says Dr. Fitts, especially if he has experienced something similar before or has thought about possible equipment malfunction.

Evidently man *has* experienced a particular kind of emergency and his concomitant thoughts about the malfunctions involved have led to a new development. The "emergency" is one common to almost all: cold food being served by a slow waitress to a man in a hurry. The development, now in the engineering stages at Designers for Industry, Cleveland, Ohio, is a fully electronic restaurant which automatically carries on such functions as cooking, serving, washing, cleaning, and collecting payment. The electronic restaurant has been designed, says Guilbert Hunt, the company's director of industrial design, for use in heavily populated areas, particularly for restaurants which handle a heavy volume of noon-hour business. It is equally applicable for use in transportation centers, such as airline, bus, and railroad stations, where travelers must be served quickly.

The system is designed to modular units, so that one or two units may be used separately in station lobby or waiting room. All food is deposited automatically on individual place settings which are mounted on round tables. The tables revolve through the side walls of the restaurant; "chairs" without legs are mounted on the side wall, in the form of curving, self-supporting benches which swing around the table.

The customer selects his menu by pushing the appropriate buttons on an electronic selector panel above each table. When his order is completed, the table revolves in a 180 degree arc, placing his food before him. Dishwashing, floorwashing, inventory, and ordering of foods are similarly automatic. The company's engineers point out that although the whole system is keyed to electronic operation, rapid advances in the technology of packaging and storing of foods have contributed heavily to the feasibility of the new concept.

X-ray Image Intensification System

Through a new method which is unlike ordinary fluoroscopic inspection, another major step in automatic quality control was unveiled recently when the X-ray Department of the General Electric (GE) Company demonstrated the latest in television X-ray—the GE TVX X-ray image intensification system.

The new TVX system permits economical 100% product inspection on a television-type screen, 10,000 times brighter than a conventional fluoroscopic image.

This method does not require the inspector to work in a darkened room as is done with fluoroscopic inspection which also is done in relatively short periods of time. The new TVX is bright enough for easy viewing in any normally lighted area. The viewing monitor provides the product inspector with an image size which is electronically variable from ½ to 3 times that of the original object. This enlargement is possible without greatly affecting sensitivity. The unit is comparable to a standard closed-circuit television system.

The system permits the addition of extra monitor, or any ordinary television receiver, if simultaneous observation from separate locations is desired. This TVX system allows product inspection viewing up to 1,400 feet distance between monitor and camera, with the monitor and inspector remote from any X radiation. This also permits the safe use of any X-ray intensity necessary for adequate penetration up to the limit of the associated X-ray generator.

ATOMIZER SPRAY NOZZLE spring, ball, and plunger assembly is clearly seen through X ray in this unretouched actual photograph taken from the 12-inch monitor screen of the GE TVX X-ray image intensification system.

Three basic units comprise the TVX system—the X-ray sensitive camera, the control unit, and the viewing monitor.

The camera consists of an X-ray image pickup tube, horizontal and vertical sweep subchassis and preamplifier subchassis. All of these are contained in a metal cabinet fitted with ventilating screens.

The heart of the TVX system is the tube itself and the plate used in the tube. This plate is X-ray sensitive, lead monoxide coated onto an aluminum hemispherical shape. The particular lead monoxide used, when X-ray impinged, will act as a semiconductor and lose its charge in a ratio to which the X-ray fell upon it. All intermediate steps have, in this way, been eliminated. Thus, it is possible to go directly from X-ray intelligence on this plate to a viewable video signal on the monitor.

Another decided advantage of this system over others is that a picture viewable in normal room light is available. The tube fits in a glass envelope. The X-ray would be on one side with an X-ray gun that supplies the electrons and also sweeps out the X-ray intelligence. A screen absorbs the excess electrons.

The rest of the system is very similar to closed-circuit television, in that the power chassis takes the signal and amplifies it some and gives brightness control and size control.

With TVX, the image can be magnified electronically. It can be reduced in size to ½ its original size or up to 3½ times actual size. This is an important feature in the inspection of "potted" components and similar small parts. The spacing can be blown up for more adequate inspection.

This TVX equipment is said to give 100% inspection economically and will be a boon to everyone involved in inspection work inasmuch as the work can be improved and accomplished in a more efficient manner.

Simple front-mounted controls are provided for brightness, contrast, and focus. Installation and service controls are provided for horizontal drive, size, centering, frequency, vertical hold, and linearity. Horizontal resolution of the TVX monitor is 46 lines per inch (minimum) at center of picture tube. Vertical resolution is 37 lines per inch at center of tube.

Video high-frequency response is flat to 8 mc ±1 decibel. Less than 10% tilt of peak-to-peak amplitude with 60-cps square wave. Modulated signal output for use with conventional television receivers is 0.1 volt rms video-modulated r-f into 75 ohms, tunable to standard television channels 2 through 6, double sideband r-f. Synchronizing peaks correspond to the maximum signal. Composite video output signal to monitor unit is 1.0 volt rms terminated into 75 ohms. Signal distribution, without booster simplifier is provided for remote monitors and television receivers.

Power requirements are: 110/117/125 volts ±10%, a-c, 60 cycles, single phase, 530 watts. Input power is divided as follows: camera, 55 watts; control, 305 watts; and monitor, 170 watts.

TERMINALS and thermostat assembly of heating element on electric frypan handle assembly appears on TVX X-ray image intensification system developed by GE for more efficient quality control inspection. Simultaneous viewing can be obtained with additional monitors or television receivers without booster amplifiers.

Instrument Traces Record of Solar Radiation

How to make an automatic report of the sun's radiation from dawn to dusk was explained at the University of Michigan recently by Y. T. Sihvonen of General Motors (GM) Research Laboratories' Physics Department.

Speaking before the 2nd National Conference on Applied Meteorology: Engineering, he described the spectroheliometer, a specially designed instrument that traced a continuous record of solar power for 2½ years at Miami, Fla. It was developed for studies of the sun's weathering effects on automotive finishes, fabrics, plastics, and plating at GM Research Laboratories' Florida Test Field. Before installation at Miami, it measured the sun's radiant energy over Detroit for a year so that comparative readings were obtained for both cities.

The Detroit record showed sharp variations in the amount of solar radiation reaching the ground. This so-called "solar twinkle," Sihvonen stated, resulted either from foreign particles in the air or from some form of atmospheric turbulence, or perhaps both, in Detroit's industrial atmosphere. It occurred on cloudless days. Miami's radiation pattern was much less variable because of the instrument's non-industrial surroundings.

A suitable device for long-term solar research, the spectroheliometer measures automatically not only the total amount of the sun's energy blanketing the earth, but also the energy being transmitted in five different wavelength bands, Sihvonen explained.

It is mounted like an astronomical telescope for tracking the sun from its rise until its setting. Sunlight enters it through two windowed apertures. Behind one aperture is a total radiation detector and behind the other is an optical system.

The optical system separates the sunlight into its component wave lengths, and energy from each of the five different wavelength bands is measured by a highly sensitive thermopile. The thermopile generates voltage proportional to the amount of heat it receives. This is fed into an amplifier, a recorder, and an integrator for a continuous record of solar radiation.

In weathering studies, spectroheliometer data were correlated with the fading or other deterioration that occurred to paint and fabric samples exposed to the sun. One fact uncovered by this solar energy record was that the sun's rays most destructive to paints and fabrics were the least intense energy rays. Their destructive effectiveness was high, their quality low.

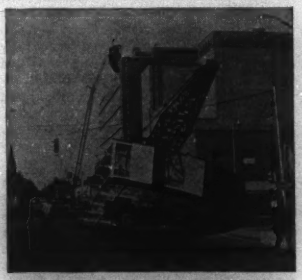
From a meteorological standpoint, information from the spectroheliometer has indicated that: (1) atmospheric absorption of ultraviolet light increases with the amount of air through which it passes. Thus, ultraviolet radiation is much stronger at noon than at sunrise or sunset; (2) at both Detroit and Miami radiation is not maximum at solar noon, as was expected, but occurs a few minutes thereafter, presumably because of the humidity variation throughout the day; and (3) the value known as the solar constant—in effect, the amount of radiation striking the earth's surface—is somewhat low and should be raised. This also has been reported by U.S. Bureau of Standards scientists.

Revolving Lighted Clock Is Run by Eight Transformers

The world's largest revolving clock, which required three months of careful study, design, and work to build, recently was erected on top of a 6-story building in Billings, Mont., in 3 days with the help of two P&H Harnischfeger Corp. cranes, Milwaukee, Wis.

The clock, its record size verified by the Smithsonian Institution, first was built by the Billings Neon Sign Company for the Carter Oil Company and then dismantled for transfer to the erection site, seven blocks away.

After dismantling, 12½ ton P&H crane with a 40-foot boom carried the largest elements of the giant timepiece through the streets of Billings in four pieces. The face was transferred in two trips, one half at a time. Each half was lashed to the boom of the P&H crane and then boomed almost to ground level to clear utility lines and traffic lights. The shaft for the clock was also transported in two pieces to the job site.



THE SMALLER of the two P&H cranes moves the second section of the face from the Neon Sign Company plant through 7 blocks of down town Billings, Mont., to the building site.

LARGER CRANE eases the second half of clock face into position 128 feet from ground level. Entire operation was accomplished in 3 instead of anticipated 5 or 6 days, and without any damage.

At the site, all four pieces were transferred to a 25-ton P&H crane with a 120-foot boom for lifting to the top of the Security Trust and Savings Bank Building, 124 feet high. After swinging pieces over the roof of the building, the crane operator worked blind and followed signals relayed by phone.

According to P. L. Berlinsky, president of Billings Neon Manufacturing Company, the erection was achieved without scratching or damaging trim or the eight transformers which had to be transferred and lifted as part of the total structure. Not one of the more than 1,000 feet of neon tubing wound through the clock face was cracked or shattered during the lifts, he said.

The 15,100 pounds of revolving weight are totally supported by a single ball bearing 3¾ inches high, 4¼ inches in diameter, which weighs only 12¼ pounds.

Mounted 128 feet from ground level, it was stated that the clock face can be read from a distance of 1¾ miles away. The minute hand is 108 inches long. The face makes one complete revolution every 1¾ minutes.

Transfer and lifts for erection were made by Strong's Crane Service in Billings. In placing the revolving unit, which included the shaft 29 inches in diameter in two pieces and the face in two pieces, the shaft had to be lowered by inches through the 24 foot tower and onto the base. The face was then lifted, one piece at a time, onto the shaft. At its height, the shaft was hoisted to the very tip of the crane boom.

The clock is said to be engineered to resist 90 mph gusts of wind and will weathervane into wind-slip clutches in a 30 mph wind.

Medical Electronics International Organization

At the invitation of Dr. V. K. Zworykin, of the Medical Electronics Center of the Rockefeller Institute, and with the cooperation of UNESCO (United Nations Educational, Scientific, and Cultural Organization) and a number of scientific societies, a group of 76 representatives from 11 countries met at the New Faculty of Medicine in Paris, France, in June 1958 to plan expanded international cooperation in the field of medical electronics.

This was the first international meeting of its kind ever held. The groundwork for the conference was under the direction of Dr. Maurice Marchal, of the School for Advanced Study, Paris, and Prof. A. Fessard, College of France, Institute Marey, who presided at the first sessions.

In opening the conference, Dr. Zworykin pictured the great potential in medical electronics. He also cited the vastness of the problems faced in terms of money and labor. It is essential, he said, that there should be well co-ordinated planning of

projects. This can be achieved by the formation of national and international committees on which doctors and electrical experts are equal partners and where the scientist and engineer provide the apparatus and leave the interpretation and application of results to the medical profession.

As a result of the meeting it was unanimously agreed by those participating to pursue the following four objectives:

1. To establish an international federation of medical electronic organizations open to societies and individuals from all countries of the world.

2. To plan a full-scale international meeting to be held in Paris, France, in the Spring of 1959 by election of an interim executive committee.

3. To co-operate in establishing an international bibliography on medical electronics with references to be contributed by the participants for their respective geographical and technical areas. A start on such a bibliography has been made under Dr. Zworykin's direction in the United States and has been published by the Institute of Radio Engineers.

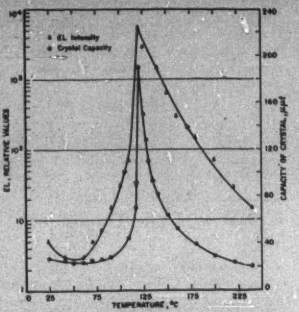
4. To draft a constitution for an international body, and consider formal association with UNESCO (C.I.O.M.S.)—approval to follow discussion at the next spring meeting.

Interim officers elected by the group include: Dr. V. K. Zworykin (U.S.), president; Dr. M. Marchal (France), vice-president; Dr. C. N. Smyth (England), vice-president and chairman of publications committee; Mr. B. Shackel (England), treasurer; Dr. A. Remond (France) and C. Berkley (U.S.), secretaries; and Prof. Sakomoto (Japan), Prof. O. Wyss (Switzerland), Dr. D. H. Bekkering (Holland), advisors.

Electroluminescence from Barium Titanate

Electroluminescence from the surface layer of barium titanate has been observed at the National Bureau of Standards (NBS) and is now being used as a tool to study the material itself. The light emission, which is extremely low in both intensity and efficiency, occurs when an r-f voltage is applied to the $BaTiO_3$ sample. Data obtained from the emitted light have led to an understanding of the mechanism by which the light is generated. This, in turn, provides knowledge about the unusual surface layer of barium titanate.

Barium titanate is used extensively in electronic devices because of its desirable dielectric and piezoelectric properties. Important applications of this material include high-capacity miniature capacitors, and transducers used in accelerometers, sound detectors, and ultrasonic transmitters. In addition, $BaTiO_3$ memory elements for use in computers are now in the developmental stage in many laboratories. However, these memory units, at present, tend to fatigue or "forget." The fact that different types of electrodes



STUDIES on electroluminescence from the surface of barium titanate crystals conducted at NBS are demonstrated in graph of emission intensity vs temperature which shows that intensity increases by a factor of about 1,000 at the Curie point of the crystal.

have a direct influence upon this characteristic—a dependence which implies a surface effect—has emphasized the need for surface layer studies.

To produce light emission from the surface of $BaTiO_3$, the most satisfactory arrangement is a concentric configuration of the electrodes. This concentrates the r-f field around the small center electrode and produces maximum light output. Although various metals serve successfully as electrodes, best results are obtained from either indium–gallium rubbed directly on the crystal surface or evaporated silver soldered with indium.

The studies conducted with this arrangement show that at the Curie point (the temperature above which ferroelectric materials lose their spontaneous polarization) of $BaTiO_3$, the light emission intensity jumps to about 1,000 times its value at lower temperatures. This effect is attributed to the fact that at the Curie point, the surface dielectric constant remains stable while the bulk dielectric constant increases by a factor of 8 or 10. Thus, more voltage is applied across the surface layer, causing an increase in intensity. A similar phenomenon occurs at frequencies corresponding to piezoelectric resonances. The resonances also produce increases in light emission because the bulk properties change while the surface properties remain stable.

The emitted light is generally yellow, but its color depends somewhat on the type of electrode employed. Special emission data show that light is emitted from 7,000 to 3,000 Angstrom units—indicating photon energies as high as 4 electron volts. Such energies are considerably above the 3-electron-volt optical absorption edge of the $BaTiO_3$ crystal. The theory introduced to account for light emitted with energies higher than expected is the "field emission" or the "avalanche breakdown" mechanism. The electrons that are necessary for electroluminescence in $BaTiO_3$ come from the metallic electrode to the adjacent surface layer by field emission.

These data and additional facts are explained in greater detail in "Light Emission from the Surface Layer of $BaTiO_3$, $SrTiO_3$, and Associated Materials," by G. G. Harman, *Physical Review*, 111, 27 (July 1, 1958); "Electroluminescence from $BaTiO_3$ Single Crystals," by G. G. Harman, *Bulletin*, American Physical Society, Series II, 1, 112 (March 15, 1956); and "Photon Emission from Avalanche Breakdown in Silicon," by A. G. Chynoweth and K. G. McKay, *Physical Review*, 102, 369 (April 15, 1956).

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

BOILING WATER REACTORS. By A. W. Kramer. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 563 pages, 6½ by 9¼ inches, bound. $8.50. A brief history is given of the boiling water reactor concept and of the early experiments at Argonne, including the development and operation of the Experimental Boiling Water Reactor (EBWR). The various Borax experiments and General Electric Company's Vallecitos plant are described in detail. In addition, a thorough explanation is given of the physics underlying the design of the various reactor plants. The book, a volume in the Atoms for Peace presentation set, concludes with a discussion of present and future research and development programs on boiling water reactors.

CHAMBER'S TECHNICAL DICTIONARY. Edited by C. F. Tweney and L. E. C. Hughes. Third edition. Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1958. 1,028 pages, 5½ by 8¼ inches, bound. $7.50. A new edition of a standard reference work encompassing the fields of science, engineering, and manufacturing, the dictionary contains new terms and older terms that have been revised where necessary to include new aspects.

ECONOMIC OPERATION OF POWER SYSTEMS. By L. K. Kirchmayer. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1958. 260 pages, 6 by 9¼ inches, bound. $12. In presenting new analytical and computing techniques that have resulted in significant savings for electric utilities, the author shows how matrix methods are employed to derive transmission-loss formulas, which form the basis for computational procedures utilized in digital computers. The application of both analog and digital computers to the problems of calculating transmission-loss formulas and generation schedules is also treated.

ELECTRONIC ENGINEER'S REFERENCE BOOK. Edited by L. E. C. Hughes. Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1958. 1,511 pages, 5 by 7½ inches, bound. $18. This handbook, written from the point of view of British practice, covers the following areas: fundamental concepts; radiations, including infrared and ultraviolet sources with their industrial and medical applications; electron tubes, including design of tubes and measurement by electronic instruments; materials, particularly those that are magnetic; vibrations; computers; and automation.

ELSEVIER'S DICTIONARY OF NUCLEAR SCIENCE AND TECHNOLOGY. Compiled by W. E. Clason. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1958. 91 pages, 6 by 9 inches, bound. $25. This dictionary contains over 4,000 words which are defined in English, with a clear distinction between American and British usage. Each word is defined according to the most precise international standard available. Corresponding terms given in French, Spanish, Italian,

Dutch, and German are arranged horizontally across the facing page. An alphabetical list at the conclusion of the book provides a cross reference from the terms in the non-English languages to the English equivalent.

ENGINEERING DRAWING. By Frank Zozzora. Second edition. McGraw-Hill Book Company Inc., 330 W. 42nd St., New York 36, N. Y., 1958. 440 pages, 8½ by 11¼ inches, bound. $6.50. A text covering the fundamentals of engineering drawing, descriptive geometry, and graphical analysis, this revised edition contains new chapters on structural drawing, charts and graphs, electrical drafting, and descriptive geometry. New material has been added to the sections on freehand drafting, geometrical constructions, dimensioning, and cams and gears.

FLUID FUEL REACTORS. Edited by J. A. Lane and others. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 979 pages, 6½ by 9¼ inches, $11.50. Three basic types of fluid fuel reactors are studied. The first is the aqueous homogeneous reactor. Such factors as nuclear characteristics, properties of aqueous fuel solutions, technology of aqueous suspensions, chemical processing, and design and construction are treated. The second is the molten-salt reactor, with consideration of the chemical aspects, construction materials, nuclear aspects, and heat-transfer systems. The last type presented is the liquid-metal fuel reactor with treatment of such factors as reactor physics, composition and properties of liquid-metal fuels, construction materials, chemical processing, and engineering design. This volume is in the Atoms for Peace presentation set.

FUNDAMENTALS OF RADIO AND ELECTRONICS. Edited by W. L. Everitt. Second edition. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1958. 805 pages, 6¼ by 9¼ inches, bound. $11. This edition has been enlarged to include many of the developments which have taken place since the first edition appeared in 1942. Among those aspects given new or additional coverage are the transistor as a supplement to or a replacement for the vacuum tube, color television, radar and navigational aids, and various electronic devices for control or measurement.

HANDBOOK OF PHYSICS. Edited by E. U. Condon and Hugh Odishaw. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1958. Various pagings. 7¼ by 10¼ inches, bound. $25. This book presents the principles, concepts, and mathematical methods of all branches of classical and modern physics. The main sections of this comprehensive handbook are mathematics, mechanics of particles and rigid bodies, mechanics of deformable bodies, electricity and magnetism, heat and thermodynamics, optics, atomic physics, physics of the solid state, and nuclear physics. These nine sections are divided into as many as thirteen chapters, each by a specialist and each concluding with a list of selected references.

INDUSTRIAL ELECTRONICS HANDBOOK. Edited by W. D. Cockrell. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1958. Various pagings. 6¼ by 9¼ inches, bound. $22.50. This handbook has nine sections dealing with basic engineering and mathematics, physical laws, control elements, power supplies, control circuits, circuit applications, mechanical design, ultimate utilization requirements, and technical information sources. Among the specific aspects given extended treatment are computers, industrial instrumentation, regulators, transducers, amplifiers, electronic switches, and multiphase power rectifiers. Emphasis is placed on application and the user's needs.

INTRODUCTION TO THE DESIGN OF SERVOMECHANISMS. By J. L. Bower and P. M. Schultheiss. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1958. 510 pages, 6 by 9¼ inches, bound. $13. The book gives a basic explanation of stability and feedback design, both single and multiple loop. The author attempts to provide a systematic approach to design problems and the principal performance requirements entailed such as harmonic response, time response, error coefficients, and noise response. Attention is also given to the common aspects of nonlinear operation, and an appendix is included which covers servomechanism components.

THE JUNCTION TRANSISTOR AND ITS APPLICATIONS. Edited by E. Wolfendale. Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1958. 394 pages, 6¼ by 9½ inches, bound. $7.50. A thorough account of the physics of p-n and p-n-p structures is followed by a discussion of the design of circuits around the transistor. Topics discussed are general four-terminal networks and the transistor equivalent circuit, d-c biasing and audiofrequency amplification, high-frequency amplification, class C amplification, sinusoidal oscillators, amplitude modulation and demodulation, and the junction transistor in nonlinear circuits.

MATERIALPRÜFUNG MIT RÖNTGENSTRAHLEN. By Richard Glocker. Fourth edition. Springer-Verlag, Berlin, West Germany, 1958. 530 pages, 6½ by 9½ inches, bound. DM 61.50. A manual on the X-ray examination of materials, particularly metals, some two thirds of the book is devoted to the use of X rays in crystallography covering both the theoretical and practical aspects, including a considerable amount of tabular data for quick reference. Other topics covered include the properties of X rays, spectrum analysis, and the determination of defects in metals. There are also an appendix of mathematical examples and a bibliography of some 700 items.

THE METAL THORIUM. Edited by H. A. Wilhelm. American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio, 1958. 397 pages, 6 by 9¼ inches, bound. $10. This is a collection of papers on various aspects of thorium. Topics discussed include: production of thorium compounds; consumable-electrode arc melting; electrolytic refining; physical constants, crystal structure, and thermodynamic properties; electronic structure; mechanical properties of thorium and high-thorium alloys; fabrication and cladding; corrosion; effects of irradiation; metallography; and chemical and spectrographic analysis. The papers were presented at a conference held in Cleveland in 1956.

OPERATIONAL RESEARCH IN PRACTICE. Edited by Max Davies and Michel Verhulst. Pergamon Press, 122 E. 55th St., New York 22, N. Y., 1958. 201 pages, 6¼ by 10 inches, bound. $12. The book comprises a report of a NATO conference on what operations research can do, and how various operations research techniques have been applied to specific problems such as methods of air defense, systems of evaluation and military planning, logistic and transport operations, and war games. The interrelation of military and industrial operations research is brought out. A considerable amount of the material included has application to civilian and industrial goals. The book was published for the Advisory Group for Aeronautical Research and Development.

THE PLASMA IN A MAGNETIC FIELD. A symposium on Magnetohydrodynamics. Edited by R. K. M. Landshoff. Stanford University Press, Stanford, Calif., 1958. 130 pages, 6¼ by 9¼ inches, bound. $4.50. The papers included in this book examine how magnetic fields influence and are influenced by plasmas. Section 1 deals with simplification of the orbit analysis of important configurations; section 2 with the instability occurring at the interface between a plasma and a magnetic field. The concluding section deals with the transfer of energy between a magnetic field and a plasma.

THE PREDICTION OF BALLISTIC MISSILE TRAJECTORIES FROM RADAR OBSERVATIONS. By I. I. Shapiro. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1958. 208 pages, 7½ by 10¼ inches, bound. $7. This is an attempt to develop methods, based on the statistical theory of parameter estimation, that can be used to determine ballistic missile trajectories. This information is based on observations of the missile by monostatic radars located at one or more sites. Primary consideration is given to maximum likelihood parameter estimates, and an analysis of the random errors associated with predictions based on this method is also given. Changes in the prediction method necessary to account for the earth's rotation and oblateness are developed.

SAMPLED-DATA CONTROL SYSTEMS. By J. R. Ragazzini and G. F. Franklin. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York, N. Y., 1958. 331 pages, 6¼ by 9¼ inches, bound. $9.50. An analysis and design of sampled-data feedback and control systems is presented. Sampled-data theory is developed and serves as a base for the analysis and synthesis of linear digital systems, pulsed continuous systems, and their combinations found in practice. In addition, the subject is treated broadly to include applications in the fields of communications, data processing, and filtering. A particular feature is the discussion on the use of digital computers as in-line controllers.

THE SHIPPINGPORT PRESSURIZED WATER REACTOR. By the U. S. Atomic Energy Commission, Division of Reactor Development, Naval Reactors Branch. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 588 pages, 6½ by 9½ inches, bound. $9.50. All aspects of the design and construction of the Shippingport reactor are discussed. Among the topics included are the factors entering into the selection of plant design parameters; reactor design, fuel element development, and core construction; radioactive waste disposal system; electrical and mechanical components used in the reactor plant; shieldings of the reactor plant and waste disposal facilities; hazards evaluation; a description of the turbine-generator plant; and training of personnel. This is a volume in the Atoms for Peace presentation set.

SODIUM GRAPHITE REACTORS. By Chauncey Starr and R. W. Dickinson, Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 288 pages, 6½ by 9½ inches, bound. $6.50. Placing emphasis on the Sodium Reactor Experiment (SRE), the book covers such aspects as the reactor and its shielding, cooling, and fuel-handling systems; nuclear, heat-transfer, and transient characteristics; design and development of components; and installation of equipment and operation of the plant. In addition, information of a general nature is included dealing with the origin of the sodium graphite concept, the technologies of sodium, graphite, and zirconium as they relate to sodium graphite reactor design, and fuel element development. This is a volume in the Atoms for Peace presentation set.

SPACE-CHARGE WAVES AND SLOW ELECTROMAGNETIC WAVES. By A. H. W. Beck. Pergamon Press, 122 E. 55th St., New York 22, N. Y., 1958. 396 pages, 5½ by 8½ inches, bound. $15. A unified picture of the small-signal operation of modern microwave tubes is presented. The major portion of the book is concerned with a generalized treatment based on Maxwellian electrodynamics, from which is derived the concept of space-charge waves which can be used to interact with slow circuit waves. Special aspects are then discussed in relation to klystrons, traveling-wave amplifiers, backward-wave oscillators, and carcinotrons. An appendix deals with measurements on circuits, the theory of the maintenance of electron beams, and Llewellyn's electronic equations.

THEORETICAL ELECTROMAGNETISM. By W. R. Myers. Butterworth & Co. Ltd., Toronto 6, Ont., Canada, 1958. 274 pages, 5½ by 8¼ inches, bound. $8.50. Areas

Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint of a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 20 W 39 St., New York 18, N. Y.

covered in this volume are: electrostatics, magnetostatics, electromagnetic induction, Maxwell's equations and circuit concepts, electromagnetic waves, and a selected group of worked-out problems in electrostatics. Vector methods are used throughout and the rationalized meter-kilogram-second-coulomb system of units has been adopted.

THEORY OF A-C CIRCUITS. By Sylvan Fich and J. L. Potter. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1958. 453 pages, 6¼ by 9¼ inches, bound. $11.35. Beginning with basic energy and power relations, this book continues with the theory and application of phasors; the definition of a complex frequency, resonance, poles, and zeros; and the fundamentals of network theory. A thorough discussion of polyphase circuits and of Fourier analysis and Laplace transformers is then presented along with the synthesis of lossless networks from poles and zeros.

TRANSFORM METHOD IN LINEAR SYSTEM ANALYSIS. By J. A. Aseltine. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1958. 300 pages, 6¼ by 9¼ inches, bound. $8.50. Special emphasis is placed throughout on the ways in which the use of integral transformations can unify the methods of system analysis through the concept of the system function. The first half of the book deals with the Laplace transform and its application to problems in electricity and mechanics. This is followed by Fourier transforms and their application to problems involving noise. In conclusion, the Mellin transform is introduced as a method suitable for the solution of a class of variable-coefficient equations.

TRANSISTOR TECHNOLOGY, VOLUME III. Edited by F. J. Biondi. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1958. 416 pages, 6¼ by 9¼ inches, bound. $12.50. This last volume of an extensive work deals with the preparation of junctions; fabrication technology, including such processes as etching, alloying, and diffusion, photoengraving techniques, and procedures for making contacts; information on measurement and characterization; and laboratory and field use reliability. The material is equally divided between that of a general nature and that which is specific to germanium and silicon.

THE TRANSURANIUM ELEMENTS. By G. T. Seaborg. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 328 pages, 6½ by 9½ inches, bound. $7. The author begins with the discovery of plutonium in 1940 as the result of the bombardment of natural uranium with deuterons in a cyclotron. He then discusses the chemical properties of the actinide elements, ranging from thorium to Mendelevium. The concluding portions of the book are concerned with the nuclear properties of the transuranium elements and the possibilities for new elements. This is a volume in the Atoms for Peace presentation set.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

SPECIFICATION FOR MILD STEEL ARC WELDING ELECTRODES. Changes in the specification for mild steel electrodes are contained in this booklet prepared by the American Welding Society (AWS) and the American Society for Testing Materials (ASTM). Among the major changes in the specification are the following: three new iron powder electrodes, two of which are low hydrogen electrodes; new E70 mild steel classification containing six electrode types; certain electrodes can be listed now in the E70 series as well as the E60 series; a new requirement has been added stating that chemical requirements must be met with certain electrodes to ensure the deposition of mild steel weld metal; and in the appendix, two very useful tables have been added showing the mechanical properties to be expected in the as-welded condition, and giving a comparison of current ranges. Copies of the booklet may be obtained from the Technical Department, AWS, 33 W. 39th St., New York 18, N.Y., for 50¢.

JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS (NBS), September 1958, Volume 61, Number 3. Published monthly, this journal presents complete papers reporting technical investigations. The September issue contains papers dealing with vibration–rotation bands of ammonia; evaluation of tensile, compression, torsional, transverse, and impact tests and correlation of results for brittle cermets; redetermination of mass spectra of deuteromethanes; effect of strain-temperature history on the tensile behavior of titanium and a titanium alloy; propagation of very-low-frequency pulses to great distances; and transmission and reflection of electromagnetic waves in the presence of stratified media. The journal, prepared by NBS, is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., at 60¢ for a single copy, and $4 for a year's subscription ($1.25 additional for foreign mailing).

FUNDAMENTALS OF TRANSISTORS, 2nd edition. By Leonard Krugman, this edition of a book which first appeared in 1954 contains a great deal of new material. Detailed coverage is given to such semiconductor devices as surface barriers, intrinsic, drift, avalanche, and spacistor types. These are in addition to all of the types which appeared years ago and still are in use. The volume will be republished for the British Commonwealth (exclusive of Canada) by Chapman & Hall of London, England. The book is available through John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y., at $3.50.

RANDOM VIBRATION. Edited by S. H. Crandall, Massachusetts Institute of Technology, the book is a set of notes written especially for engineers who are already familiar with classical vibration theory and who need an introduction to the random vibration problem which has become so important in recent years in the design and testing of missiles, jet aircraft, and other vehicles subject to random loadings. All the required basic notions of probability and statistics are developed from first principles without assuming any previous training in statistics. The first six chapters present the basic principles and background. The last six chapters discuss specific problems of design and testing. The 418-page book may be ordered, at $10 per copy, from Technology Store, 40 Massachusetts Ave., Cambridge 39, Mass.

OFFICE OF TECHNICAL SERVICES (OTS). Development of a new medium for protection of electronic equipment in missiles against vibration and shock is described in a U. S. Air Force report recently released to industry through the OTS. The report, *PB 151005*, by R. H. Jacobson, Wright Air Development Center is "New Medium for the Protection of Electronic Equipment Against Shock and Vibration," $2.75. The Navy has released two studies: *PB 131581*, "Description and Properties of Type B Silver-Silver Chloride Reference Electrode for Cathodic Protection," Mare Island Shipyard, Mar. 1956, 50¢, which describes the development of an improved trailing reference electrode for use in cathodic protection of ships; and *PB 131582*, "The Change in Electrical Resistivity of Some High Polymers during Isothermal Polymerization," by J. A. Aukward, R. W. Warfield, and M. C. Petree, Nov. 1956, 75¢, which contains a description of a technique for the study of the rate of polymerization, under isothermal conditions, for typical encapsulating resins. All three reports are available from OTS, U. S. Department of Commerce, Washington 25, D. C.

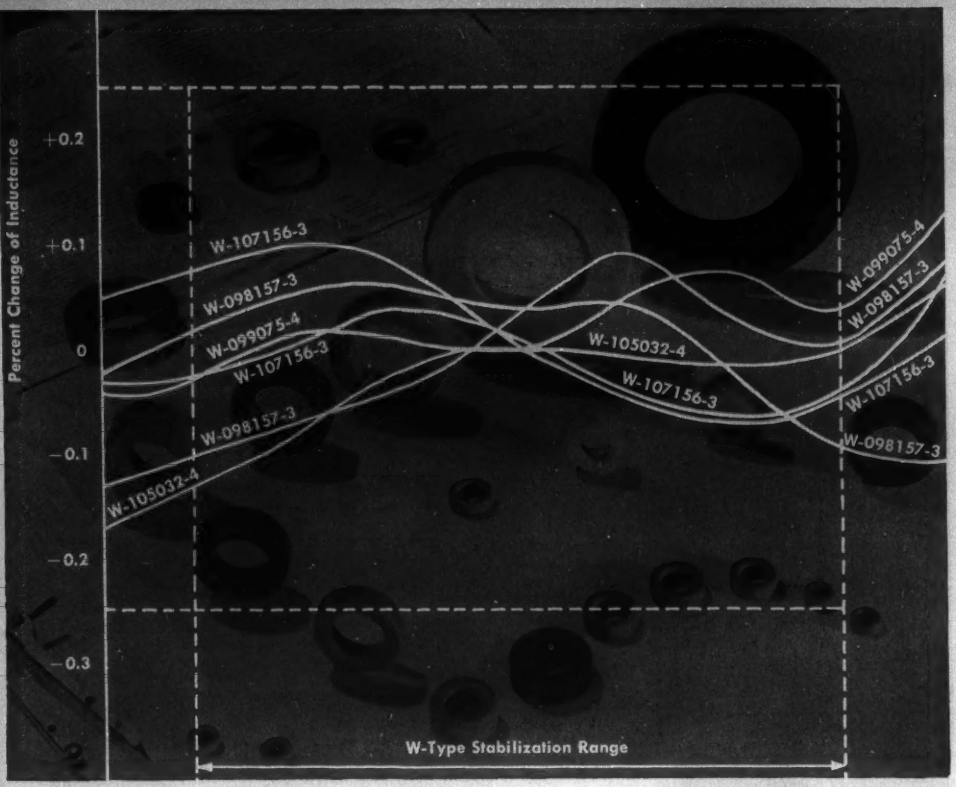
INSTRUMENT AND CONTROL ENGINEERING. By Lloyd Slater, executive director of the Foundation for Instrumentation Education Research, Inc. (FIER), this booklet discusses the field of instrument and control engineering in terms of functions, status, and career opportunities. A sizable bibliography is included. Although the booklet is aimed at inducing young people to enter into advanced education as a technician or graduate specialist in the field, it is hoped that it will prove to be of value also to scientists and engineers who wish to learn more about the field. The monograph is available from Bellman Publishing Company, Cambridge 38, Mass., for $1. All author's royalties will go to FIER.

SELECTED ABSTRACTS FROM THE JOURNAL OF THE BRITISH INSTITUTION OF RADIO ENGINEERS, 1946-58. This reference work gives informative abstracts of the principal papers and reports which have appeared in the Institution's journal during the years noted. The contents include papers on the subjects of astronomy, nuclear engineering, magnetic materials, waveguides, radiation counters, transmitters, navigational aids, and automatic computers, as well as other pertinent topics. The arrangement of the abstracts is by subject according to the Universal Decimal Classification, and the entries are fully cross-referenced. Copies of the 72-page publication may be obtained from the Institution, 9 Bedford Square, London, WC 1, England, price 3s.6d.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC). Several publications have been made available by the IEC. The first of these is the newest section of the 2nd edition of the International Electrotechnical Vocabulary (IEC publication 50), Group 35, Electromechanical Applications, containing about 90 terms and definitions in English and French, with equivalent terms in 6 other languages, for electromechanical applications in the fields of materials handling, automotive industry, agricultural machinery, clocks, signalling devices, and others. $2.40 per copy. Recommended standards now available include: "Recommendation for an International Specification for Aluminum Alloy Conductor Wire of the Aluminum-Magnesium-Silicon Type," Publication 104, 60¢ per copy; and an amendment to the 1st edition and 1st and 2nd appendixes of IEC publication 65, "Safety Requirements for Electric Mains Operated Radio Receivers Apparatus," 80¢ per copy. Publication 65, including both appendixes and the new amendment, also is available at $6 per copy. All IEC publications may be purchased from American Standards Association, 70 E. 45th St., New York 17, N.Y.

REACTOR FUEL TECHNOLOGY. The Atomic Industrial Forum recently announced publication of the proceedings of its recent conference on Reactor Fuel Technology. The 120-page illustrated volume includes papers and discussion on: factors in economic selection of reactor fuels, blanket fuel systems, natural and enriched uranium systems, metal and alloy fuel elements, fuel cladding and canning materials, and oxide fuel elements. Topics are covered in light of their relationship to reactor types, availability and cost of materials, burnup, thermal and radiation stability, fabrication and reprocessing technologies and costs, AEC fuel prices and buy-back arrangements, and other related factors. The conference was held in May 1958 under the joint sponsorship of the Forum Committee on Reactor Materials and the Committee on Exploration, Mining, and Processing in co-operation with the Florida Nuclear Development Commission. The publication is available at $5 from Atomic Industrial Forum, Inc., 3 E. 54th St., New York 22, N.Y.

NATIONAL FIRE CODES, 1958, Volumes I-VI. Important changes in fire safety standards are incorporated in a new and revised edition of the National Fire Codes published recently by the National Fire Protection Association (NFPA). The 6-volume edition is a compilation of the 170 standards developed by NFPA in the fields of flammable liquids and gases; combustible solids, dusts, chemicals, and explosives; building construction and equipment; extinguishing equipment; electrical; and transportation and miscellaneous operations. New material in the 1958 edition includes 38 new or revised fire safety standards adopted at the 1958 NFPA Annual Meeting. It also incorporates all amendments approved by the NFPA Board of Directors up to and including July 30, 1958. The National Fire Codes, $7 per volume, may be obtained from the Publications Department, National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.



ARNOLD offers you the widest selection of Temperature Stabilized MO-PERMALLOY POWDER CORES

Arnold Molybdenum Permalloy powder cores are available with the temperature coefficient of inductance controlled within certain limits over specific temperature ranges. Most core sizes and permeability combinations can be supplied in at least one of the four different types of temperature stabilization available.

For example, most of the popular core sizes are manufactured in the new type of wide range—"W"—stabilized cores whose temperature coefficient of inductance does not exceed 0.5% over the temperature range covered by the MIL-T-27 specification of −55° C to +85° C.

This type of guaranteed maximum change of inductance with temperature, as well as the constancy of permeability with time and flux level, are of particular importance to apparatus and circuit engineers. Many precision military and industrial applications demand the uniform performance and the excellent physical properties found only in Arnold Mo-Permalloy powder cores.

For design flexibility they are furnished in a full range of sizes, up to 5.218" O.D., in four standard permeabilities: 125, 60, 26 and 14. You will find them dependable and easy to use. You will find most sizes and types in stock *now* for immediate shipment.

● Let us furnish your requirements for temperature stabilized Mo-Permalloy powder cores, or any magnetic materials you need, from the most complete line in the industry.

WSW 6999

For more information write for Bulletin PC-104B

Lists complete line of Mo-Permalloy Powder cores . . . available in 25 sizes from 0.260" O.D. to 5.218" O.D. Furnished also with various types of temperature stability from Type "A" unstabilized to Type "W" stabilized over the temperature range of −65° F to +185° F.

ADDRESS DEPT. EL-91

THE ARNOLD ENGINEERING COMPANY

Main Office & Plant: Marengo, Illinois

Reputh Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:

Boston: 49 Waltham St., Lexington Los Angeles: 3450 Wilshire Blvd.

New York: 350 Fifth Ave. Washington, D.C.: 1001-15th St., N.W.

New and Improved Products . . .

Color-Lite . . .

Designed primarily for aircraft, laboratory test equipment, missile test stand, and production-line panel illumination applications, "L" type Color-Lites may be mounted on the face of panels to illuminate instruments and gauges. This easily oriented installation eliminates the need to align light sockets each time a lens or bulb is changed. After the receptacle is screwed into the body of light, the "L" type lens may be rotated with thumb or finger to align marking. **The Sloan Company, 4101 Burbank Blvd., Burbank, Calif.**

Portable Frequency Meter . . .

A portable frequency meter for use with communications equipment designed to the latest Federal Communications Commission split-channel specifications as well as adjacent channel requirements has been made available. Capable of servicing and maintaining multiple transmitter installations operating on from one to 24

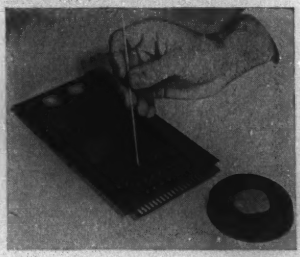
channels in the 25 mc to 470 mc communications spectrum, the unique self-contained equipment (Type 5890-B) does the task which previously required a dozen dual frequency instruments. Stability is rated at ±0.00025%. **Mobile Communications Sales Dept. Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.**

Miniaturized Frequency Shift Telegraph System . . .

A miniaturized and fully transistorized, 100 word-per-minute, telegraph carrier system, Type *23A*, trade named "Datatel," has been introduced, featuring plug-in unit construction and 45-class mechanical design. A new approach in wiring adapts the system to mechanical assembly and automatic wire-wrapping and strapping. An important feature is the use of a polar relay in the plug-in receive loop keyer circuit which permits the large number of loop options, but can be rearranged for special purpose relayless operation. **Lenkurt Electric Company, 1105 County Rd., San Carlos, Calif.**

Three New Products by I-T-E . . .

First, two newly designed *JK* and *JKL* molded-case circuit breakers have recently been introduced to provide 225 to 400 ampere continuous ratings in two thirds the space formerly required; second, a low-cost system has been developed for



remote or automatic control of the *HPL-C* line of enclosed interrupter switches, and third, a novel six-pole anode circuit breaker allows drawout of individual poles without interruption of process power. **I-T-E Circuit Breaker Company, 19th and Hamilton Sts., Philadelphia 30, Pa.**

Hysol . . .

This conductive cement based on epoxy resins is said to offer excellent bond strength and is particularly recommended for repair of printed circuits and bonding electrical components where soldering cannot be tolerated. The compound will cure fully in 24 hours at room temperature and is supplied in convenient kit form. **Houghton Laboratories, Inc., Olean, N.Y.**

Durable Image Oscilloscope . . .

This cathode-ray tube oscilloscope with a special screen phosphor can record and retain a picture for days. The Storascope is designed for recording transient pulses and signals recurring regularly or irregularly at frequencies up to 10 kc. Through the use of an automatic line-switching arrangement, the screen will record either enlarged single traces or 10 traces in succession on 10 separate lines. For continuous recording runs, a permanent low erasing voltage can be applied to the screen so that the top line is available as soon as the last line is completed. **International Telephone & Telegraph Corporation, 67 Broad St., New York 4, N. Y.**

Fast-Curing Varnish . . .

A fast-curing electrical insulating varnish, particularly adaptable to high-volume conveyorized baking systems has an oven dry time of 30 minutes at 275 F, a mil pickup of from 3 to 4 mils, a dry dielectric strength of 2,480 volts per mil, and excellent penetration, adhesion, flexibility, and toughness. **Minnesota Mining & Manufacturing Co., 900 Bush St., St. Paul 6, Minn.**

Antirepeat Control System . . .

A fail-safe, antirepeat control system prevents accidental repeat operations on single-cycling machines. The device is designed to protect personnel against injury on manually operated machines and to prevent tooling damage on automated equipment. Suitable for presses, brakes, shears, indexing units, and other equipment employing an air-operated friction clutch and spring-set brake, the system uses two separate electrical, pneumatic, and mechanical control circuits, operating in tandem. These are completely interlocked so that failure of any one automatically stops the machine at once or at the end of the cycle. **Textrol, Incorporated, 4015 Prospect Ave., Cleveland 15, Ohio.**

Pliable Conduit Can be Bent by Hand . . .

A pliable electrical conduit composed of layers of continuous metal allows maximum protection for cables, yet can be easily set and bent to negotiate corners. Despite its extreme pliability, this new conduit remains almost rigid after bending. It can be shaped to any radius without distortion or bore, and is easily cut with a knife. Specially designed adapters make it easy to join the conduit to standard electrical fittings and junction boxes. A seal-tight end fitting insures a completely dry conduit system. **Gemmer Manufacturing Co., Kopex Division, 6400 Mt. Elliott Ave., Detroit, Mich.**

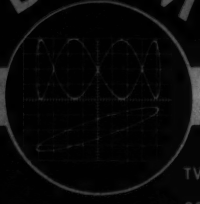
High-Speed Armature Tester . . .

Developed to test small armature windings for short circuits, open circuits, and grounded circuits at a production rate of about 600 per hour, this unit can also be used to test large armatures by using portable contact head. In operation, the armature shaft is inserted into the bored end of a pilot rod which extends outward from the panel of the machine. As the pilot rod is pushed to its inner position, it trips a limit-switch which starts the machine test cycle. **Cen-Tec Corporation, 38903 Schoolcraft Rd., Livonia, Mich.**

(Continued on page 20A)

NEW DUAL BEAM TYPE 502 OSCILLOSCOPE

Dual display on linear time base.



Dual display for X-Y curves.

TWO-GUN CATHODE-RAY TUBE.

200 μv cm SENSITIVITY, BOTH BEAMS.

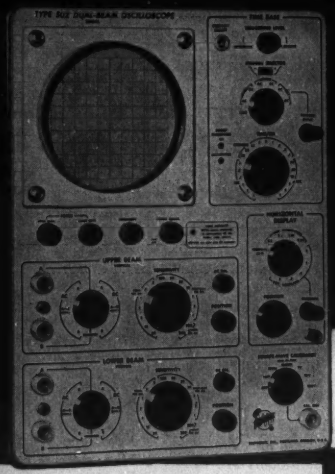
DIFFERENTIAL INPUT, ALL SENSITIVITIES.

2, 5, 10, and 20 TIMES SWEEP MAGNIFICATION.

X-Y CURVE TRACING with TWO BEAMS—(horizontal input sensitivity to 0.1 v cm).

SINGLE-BEAM X-Y CURVE TRACING at 200 μv cm, BOTH AXES.

EXTRA FEATURE—Both amplifiers have transistor-regulated parallel heater supply.



TYPE 502 CHARACTERISTICS

HIGH-GAIN AMPLIFIERS
200-microvolts/cm deflection factors, both dc-coupled and ac-coupled. 16 calibrated steps from 200 μv/cm to 20 v/cm.

Passbands — dc-to-100 kc at 200 μv/cm, increasing to dc-to-200 kc at 1 mv/cm, dc-to-400 kc at 50 mv/cm, and to dc-to-1 mc at 0.2 v/cm.

Differential Input, Both Channels—Rejection ratios: 1000-to-1 at 1 mv/cm or less, 100-to-1 at 0.2 v/cm, 50-to-1 at 5 to 20 v/cm.

Constant Input Impedance, 1 megohm, 47 μμf, both channels.

WIDE-RANGE SWEEP CIRCUIT (Common to both beams)
Single-knob control for selecting any of 22 accurately-calibrated sweep rates from 1 μsec/cm to 5 sec/cm.

Sweep Magnification—2, 5, 10, and 20 times, accurate within the maximum calibrated sweep rate.

Automatic Triggering—fully automatic, or preset with amplitude-level selection when desired. Sweep can also be operated free-running.

X-Y CURVE TRACING OPERATION
Horizontal-input amplifier permits curve-tracing with both beams simultaneously at sensitivities to 0.1 v/cm. For curve-tracing at higher sensitivities (to 200 μv/cm) with one beam, one of the vertical amplifiers can be switched to the horizontal-deflection plates.

OTHER FEATURES
Amplitude calibrator, 1 mv to 100 v in decade steps—square wave, frequency about 1 kc.

3-kv accelerating potential on new Tektronix 5" dual-beam crt. 8-cm by 10-cm linear-display area, each beam, 6-cm overlap.

Electronically-regulated power supplies. Price.....$795
f.o.b. factory

Here are a few uses for the Type 502:

IN ELECTRONICS—Use the Type 502 as a general-purpose oscilloscope and also to show simultaneously the waveforms at any two points in a circuit, e.g. input and output, opposite sides of a push-pull circuit, trigger and triggered waveform, etc.

IN MECHANICS—Display, compare, and measure outputs of two transducers on the same time base; plot one transducer output against another—pressure against volume or temperature for instance; measure phase angles, frequency differences, etc.

IN MEDICINE—Display, compare, and measure stimulus and reaction, or the outputs of two probes, on the same time base; use differential input to cancel out common-mode signals, or to eliminate the need for a common terminal; use in routine investigations, etc.

IN ALL FIELDS—The Type 502 can save you more than its cost in time—in as little as one application!

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

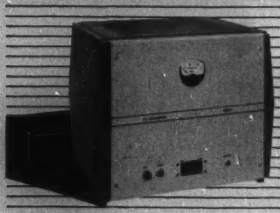
TEKTRONIX FIELD OFFICES: Albertson, L.I., N.Y. • Albuquerque • Atlanta, Ga. • Bronxville, N.Y. • Buffalo • Cleveland • Dallas • Dayton • Elmwood Park, Ill. • Endwell, N.Y. • Houston Lathrup Village, Mich. • East Los Angeles • West Los Angeles • Minneapolis • Mission, Kansas Newtonville, Mass. • Orlando, Fla. • Palo Alto, Calif. • Philadelphia • Phoenix • San Diego St. Petersburg, Fla. • Syracuse • Towson, Md. • Union, N.J. • Washington, D.C. • Willowdale, Ont.

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon., Seattle, Wash.; Hytronic Measurements, Denver, Colo., Salt Lake City, Utah.

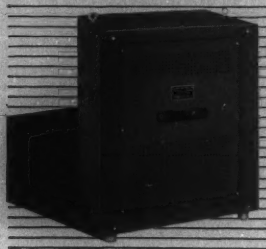
Tektronix is represented in 20 overseas countries by qualified engineering organizations.

NEW IDEAS IN PACKAGED POWER

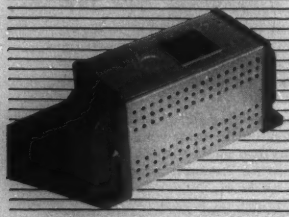
for lab, production test, test maintenance, or as a component or subsystem in your own products



New tubeless 0.1% a-c line regulators give up to 5kva out. High output and fast response result from a unique combination of semi-conductor and magnetic amplifier principles in the new Sorensen Model R3010 and R5010 a-c line regulators. Model R5010 (left) puts out up to 5kva and Model R3010, 3kva. Provision for remote sensing allows you to hold regulation accuracy at the load despite length of output leads, and, with an external transformer, permits regulation of any a-c voltage.



Broadest line of a-c regulators. A complete line of electronic a-c regulating equipment, supplying powers as high as 15kva, is manufactured by Sorenson. Single phase and 3 phase, 50, 60, 400 cps, 115 and 230 vac models are available. Good example of these is the 10kva Model 10000S supply (left). Others: Precision a-c regulators (±0.01%) for labs or meter calibration; and fast-response low-distortion a-c regulators where line transients must be reduced to a minimum.



... and rugged, economical MVR's. Low cost, low distortion, long life and a broad selection of models are outstanding features of Sorensen MVR's (Magnetic Voltage Regulators). Capacities range from 30 to 2000 va. Regulation is on the order of ±0.5%. Both harmonic-filtered and unfiltered models are available with 115vac out. Models for 6.3 and 12.6 out, unfiltered, also available.

Sorensen makes a complete line of packaged power equipment—including regulated d-c supplies, inverters, converters and frequency changers. Despite the breadth of the standard Sorensen line, our engineers are always ready to discuss your specialized power requirements up to complete power systems for complex computers or other critical equipment. Write for complete data. 8.43

Sorensen

SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. **IN WESTERN CANADA,** ARVA. **IN EASTERN CANADA,** Bayly Engineering, Ltd. **IN MEXICO,** Electro Labs, S. A., Mexico City.

New & Improved Products

(Continued from page 18A)

Lightweight Airborne Computer . . .

Operating 10 times faster than other commercially available airborne computers, it is stated that this transistorized instrument can perform 64,000 additions or take 16,000 square roots per second. Used in autopilot, air data cruise control, navigation, engine performance,

weapon delivery, and interception operations, this computer weighs 150 pounds, occupies less than 3 cubic feet of space, and uses only 60 watts of current. **Philco Corporation, 4700 Wissahickon Ave., Philadelphia 44, Pa.**

Slidewire-Tape Potentiometer with Direct Digital Readout . . .

Until this slide wire tape potentiometer was developed, a wire strung wall-to-wall was required to achieve laboratory accuracy. Now placed in a small box, the *TA'POT H5600* has a resistance range from 100 ohms to 100 kilohms with an accuracy of 0.05%. The active element of this potentiometer is a resistance wire bonded within the edge of a calibrated Mylar tape with readout through a window in the case. **Howell Instrument Company, 3101 Trinity St., Fort Worth 7, Texas.**

Microwave Radiation Detector . . .

A detector of high-intensity radar beams that fits in a shirt pocket has a neon light and earphone which give ample warning to personnel when exposed to dangerous radar beams. The intensity of the sound in the earphone is governed by the nearness of the individual to the radar transmitter. It is also useful in locating leaky waveguide joints. **Erickson Products Co., 1960 Carroll Ave., San Francisco 24, Calif.**

Fiberglas Polarizing Light Panel . . .

Cut-off of direct glare is usually accomplished by a lens or louver and the amount of reflected glare reduced by using a diffuser. A Fiberglas polarizing light panel accomplishes both of these features of selective reflectance and diffusion. **Owens-Corning Fiberglas Corporation, 16 E. 56th St., New York 22, N. Y.**

(Continued on page 22A)

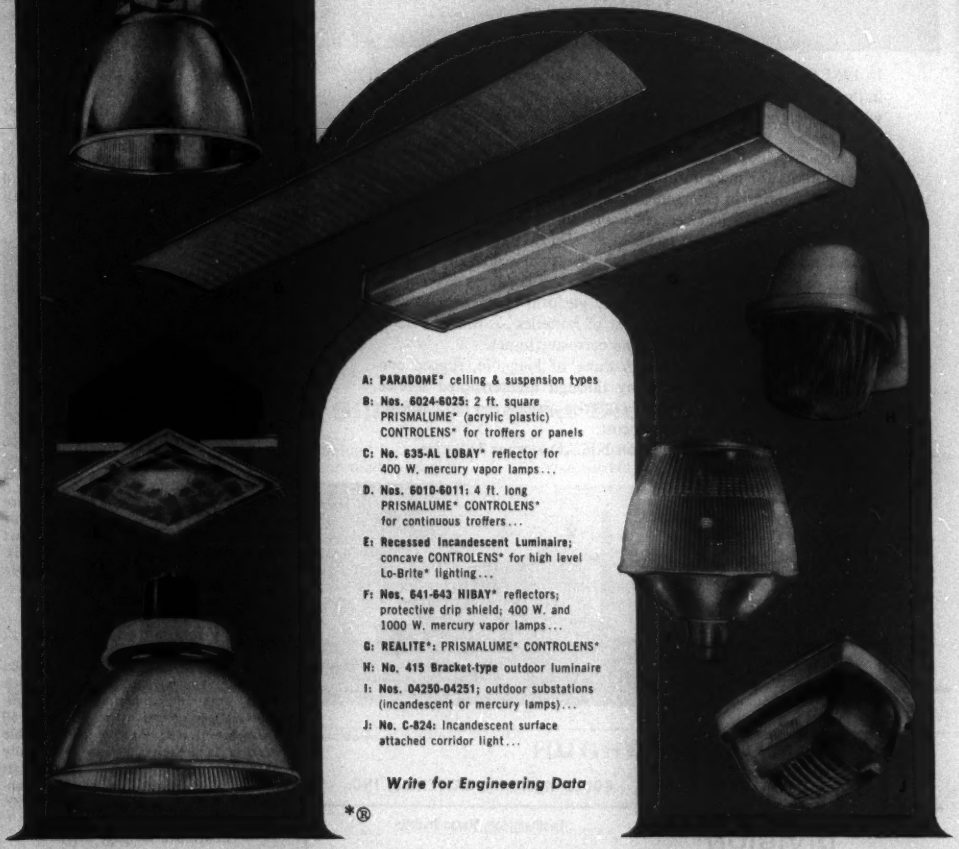
Holophane

Those who know Lighting Quality

Specify HOLOPHANE

Six decades of constant research and development have earned for Holophane engineers recognition as the foremost illumination authorities... Based on their long experience with prismatic control Holophane has provided the most efficient, economical lighting systems in every field—industrial, commercial and institutional... As an identification of quality, the name Holophane is impressed on each piece.

HOLOPHANE COMPANY, INC.
Lighting Authorities Since 1898
342 Madison Ave., New York 17, N.Y.
THE HOLOPHANE CO., LTD., 418 KIPLING AVE. SO., TORONTO 14, ONTARIO



A: **PARADOME*** ceiling & suspension types

B: **Nos. 6024-6025:** 2 ft. square PRISMALUME* (acrylic plastic) CONTROLENS* for troffers or panels

C: **No. 635-AL LOBAY*** reflector for 400 W. mercury vapor lamps...

D. **Nos. 6010-6011:** 4 ft. long PRISMALUME* CONTROLENS* for continuous troffers...

E: **Recessed Incandescent Luminaire;** concave CONTROLENS* for high level Lo-Brite* lighting...

F: **Nos. 641-643 HIBAY*** reflectors; protective drip shield; 400 W. and 1000 W. mercury vapor lamps...

G: **REALITE*:** PRISMALUME* CONTROLENS*

H: **No. 415 Bracket-type** outdoor luminaire

I: **Nos. 04250-04251;** outdoor substations (incandescent or mercury lamps)...

J: **No. C-824:** Incandescent surface attached corridor light...

Write for Engineering Data

*®

At New England Electric's Salem Harbor Plant...

In 1951 this 125-volt NICAD Nickel Cadmium battery was installed in the new Salem Harbor station of the New England Electric System where it is the normal source for circuit breaker operation and valve motors.

It also provides standby power for clock recorders, indicating lamps, motors for main turbine seal oil and bearing oil pumps, and for station lighting in emergencies.

After this battery had been in operation for six years, a regular annual inspection found it to be in excellent, "like-new" condition ... and no water additions had been necessary since installation!

Such outstanding records of reliability and economy are not uncommon with NICAD batteries. They perform better over a wider temperature range than other types of batteries ... will not freeze in any state of charge ... give off no corrosive fumes.

Combine these advantages with those of long life, rugged construction, and long-term economy through uninterrupted service, and you see why use of NICAD batteries assures the most reliable performance at the lowest annual cost.

Ask us for more information on NICAD storage batteries.

New England Electric's Salem Harbor Plant

NICAD DIVISION

GOULD-NATIONAL BATTERIES, INC.

Easthampton, Massachusetts

New & Improved Products

(Continued from page 20A)

Multipoint Recorder of Unusual Flexibility . . .

Capable of handling from 2 to 24 points by means of a simple plug-in adapter, this recorder is designed to measure any number of variables by means of a simple and inexpensive kit of change-over parts. When an additional work load is required, the operator need only change a plug-in unit and replace a dial indicator and print wheel which is mechanically geared with the selector switch. **Weston Instruments, Division of Daystrom Incorporated, 614 Frelinghuysen Ave., Newark 5, N. J.**

Temporary Jumper Clamps . . .

Two styles of insulated jumper clamps used for by-passing work area or for making temporary connections feature a wide-area, high-pressure connection with a V-shaped jaw of the aluminum-alloy head. The handle is made from tubular clear plastic with inherent high insulation and impact strength. **A. B. Chance Co., Centralia, Mo.**

Pulse Timer . . .

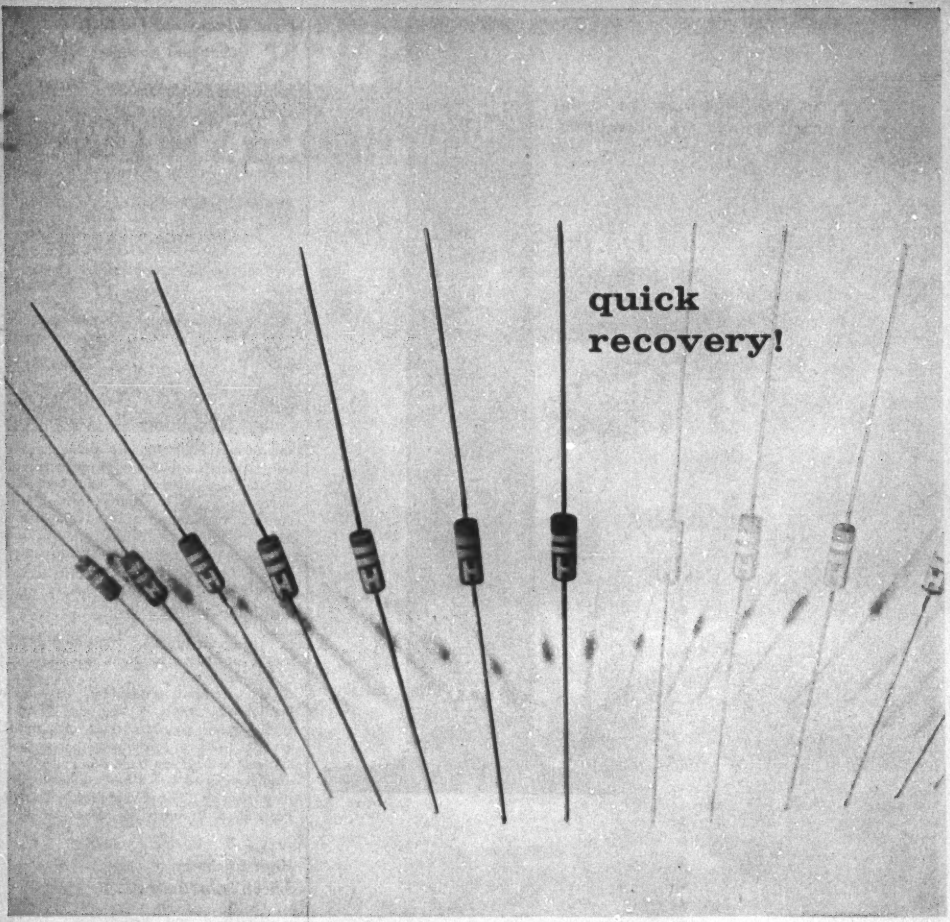
The mechanism of this d-c timer incorporates many of the features developed for the electric wrist watch. Suitable for light duty military and industrial applications where space and power are at a premium, the timer can also be used as a slow-speed d-c motor,

advertisement mechanism, pulse source timer, portable clock, time clock, marine clock, interval switch, impulse for a chart recorder, and as a low-frequency oscillator. **Hamilton Watch Company, Columbia Ave., Lancaster, Pa.**

Latching Vacuum Coaxial Relay . . .

The type *RC10* relay was designed to provide remote switching of 3⅛ inch coaxial lines in communications transmitters at frequencies up to 60 mc at 50 kw average power. Positive and reliable operation is achieved by an electrically controlled latching mechanism used in conjunction with vacuum enclosed contacts. **Jennings Radio Mfg. Corp., P.O. Box 1278, San Jose, Calif.**

(Continued on page 24A)



Reliable Hughes Silicon Junction Diodes

With recovery to 400 K ohms (minimum) in 1 microsecond...Hughes high-speed silicon diodes reliably meet the quick recovery requirements of most germanium types, and in addition, stand up under high voltages at high temperatures. In fact, the breakdown voltages increase with temperature...thereby providing maximum protection when temperatures reach unexpected levels. With this order of reliability, Hughes quick recovery silicon diodes assure dependability under the most severe operating temperatures.

Typical performance levels:

Breakdown voltages at current of 0.1 mA from 30-200 volts.

Ambient operating temp. —80°C to +150°C

Reverse current—as low as 1 μA at —175 volts and 25°C

—as low as 30μA at —175 volts and 100°C

Special high conductance types in the quick recovery series are available in all voltage classes. No matter what your problem, chances are that there is a Hughes diode to meet your need. Write today for a complete data sheet on the Hughes quick recovery silicon diode —or any other Hughes semiconductor device.

Address: HUGHES PRODUCTS, Marketing Department, International Airport Station, Los Angeles 45, Calif.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

© 1959, HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DEVICES · STORAGE AND MICROWAVE TUBES · CRYSTAL FILTERS · OSCILLOSCOPES · RELAYS · SWITCHES · INDUSTRIAL CONTROL SYSTEMS

Structural steel can now be delivered promptly and when required.

ONE

makes

FOUR

FOUR distinct divisions in **one** steel company, inter-related, specialists in their own field of endeavor and singly managed.

Some clients take advantage of all **four**, others one or more.

Fabricated Structural Steel and Fabricated Reinforcing Steel for Bridges, Commercial and Industrial Buildings: Schools, Hospitals, Power Plants, Coal Washing Plants.

Galvanized Structural Steel for Electrical Transmission Towers and Substations.

Carbon Steel Warehouse Products: Structural and Bar Shapes, Plates, Hot and Cold Finished Bars, Construction Products.

Pressure Vessels fabricated to the ASME Code from Carbon, Alloy, and Alloy Clad Steels for the Chemical and Petroleum Processing Industries.

for over 40 years

FLINT STEEL CORPORATION

TULSA . . . MEMPHIS

New & Improved Products

(Continued from page 22A)

Miniature Tantalum Capacitor . . .

This electrolytic capacitor was developed in response to demands for smaller capacitors with higher capacity and lower leakage currents. It has a case

size of less than $\frac{1}{16}$ inch diameter and only slightly more than $\frac{1}{8}$ inch in length. D-c leakage current is less than one microampere. **P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.**

Tubeless Photoelectric Lighting Control . . .

Using no tubes or transistors *6600A* uses a broad area cadmium sulfide photocell to drive a Sigma relay directly. Electrical specifications include 1,000-watt load rating, supply voltage 105-135 volts, 50/60 cycles, inrush current rating 100 amperes, power consumption less than 0.5 watt average, turn-on 1.5 $\pm$ 0.5 foot-candles, turn-off 1 to 2 foot-candles higher than turn-on. **The Fisher-Pierce Co., 67 Pearl St., S. Braintree 85, Mass.**

High Efficiency Silicon Solar Cells . . .

Designed and manufactured to extremely rigorous military specifications these rectangular silicon cells are capable of conversion efficiencies of 10% or approximately 9 watts per square foot of active cell area in bright sunlight. **International Rectifier Corporation, 1521 E. Grand Ave., El Segundo, Calif.**

New Battery Plate . . .

Where batteries are idle for periods of time, the Siliconic Plate will prevent migration of materials to the negative plate, thereby reducing self-discharge within the cell. Arsenic and silver cobalt sulphates are introduced into the active materials of the positive plate. When this occurs, the silver and cobalt migrate to all positive grid members and collect there to form an insoluble oxide surface. This sheath then prevents grid separation, the most common cause of battery failure. **Gould-National Batteries, Inc., Trenton, N. J.**

(Continued on page 26A)

DOSSERT MICON*

(Tapeless Underground Connector)

More COMPACT
More RELIABLE
LOWER in COST

MICON is a Dossert Mfg. Corp. trademark for a tapeless underground connector especially designed for residential and industrial underground distribution systems. This brand of connector is fully insulated for joining up to 8 electrical cables where watertightness must be insured. MICON tapeless connector is simple in concept and well proven principles have been used in its design. No extra components are needed to accommodate a wide range of cable sizes in any outlet position.

MICON brand tapeless connector has many outstanding features and advantages which constitute a substantial improvement over older style and competitive fittings. The most important ones are:

- Lower cost of complete fitting.
- Less field time required for installation.
- Wide cable range without accessories.
- No plastic parts to crack or chip.
- No extra bushings required to fit different insulations.
- All parts are designed for easy accessibility and easy installation.
- Compact design conserves manhole space.

Dossert MICON brand tapeless Crab-type Connector is especially designed for joining up to 12 electrical cables. This connector is an original Dossert design and adheres to the same principle as the tapeless type. Write for special catalog.

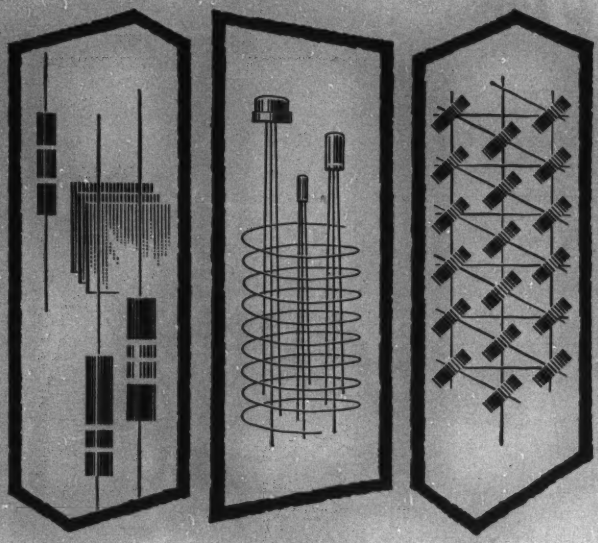
Request also complete UNDERGROUND CATALOG UG 53-1

*Trade Mark. Reg. Trade Mark applied for.

50

DOSSERT MFG. CORP.

249 Huron Street, Brooklyn, New York



VARIED ENGINEERING ASSIGNMENTS STIMULATE INTEREST ON RCA PROJECT BMEWS

Positions with RCA's project for the new Ballistic Missile Early Warning System involve a broad range of duties. BMEWS problems demand new, adventurous approaches. Your headquarters will be in New Jersey at a location suburban to Philadelphia. You'll have the opportunity to demonstrate the feasibility of your engineering planning under actual environmental conditions in the Far North. Additional compensation for Far North trips. BMEWS' challenge requires experience in: Heavy Ground Radar Systems, Digital Computer Systems, Communications Systems, Data Handling.

Broad and liberal RCA benefits program to build security for you and your family • Work with the very latest in facilities and equipment • Every opportunity for progress in an RCA career.

TO ARRANGE CONFIDENTIAL INTERVIEW

Please send complete resume to:

Mr. Robert Vincent
RCA, Dept. BM-3A
1809 Bannard Street, Riverton, N.J.

EQUAL OPPORTUNITY EMPLOYER

RCA **RADIO CORPORATION of AMERICA**

New & Improved Products

(Continued from page 24A)

Slotted Wiring Duct . . .

A rigid vinyl wiring duct features slots instead of holes to speed installation of large lugged wires on control panels, switchgear, and electronic consoles. The duct eliminates harness lacing or lug attachment after assembly, and

holds all wires in place with snap-on cover. It is available in standard sizes of ⅜ inch by ⅜ inch to 4 inch by 3 inch sections in standard lengths up to 12 feet. **Taylor Electric, 15400 Dale, Detroit 23, Mich.**

Differential Voltage Sensing Relay . . .

Employing a printed circuit with a standard plug-in *SPDT* relay to open and close circuits, a zener diode and transistors in the sensing circuit assure high sensitivity. The unit provides a control range of 70% to 100% of rated voltage for both drop-out and pick-up with a minimum one-volt differential. Applications range from power and lighting systems to radar, microwave relays, and missile control stations. **Lake Shore Electric Corporation, 205 Willis St., Bedford, Ohio.**

Extra Heavy-Duty Cutout . . .

One of the first completed designs to emerge from this company's new electrical research laboratory is a single-vent, small-bore cutout, rated extra heavy duty (10,000 amperes at 5.2 kv and 7.8 kv, and 8,000 amperes at 15 kv). This cutout is specifically designed to keep step with modern, high-capacity utility systems. **Hubbard & Co., 200 S. Michigan Ave., Chicago 4, Ill.**

Light Adjusting Closed Circuit Television . . .

A closed-circuit television system with a built-in, fully automatic light adjustment control will instantly adjust to variations in light level up to 1,000 to 1. The system is ideally suited where lighting conditions are subject to rapid change and the requirement calls for optimum visual performance at all times. **Kin Tel, A Division of Cohu Electronics, Inc., 5725 Kearny Villa Rd., Box 623, San Diego 12, Calif.**

2. **PUSH UP** . . . the Roeclamp is ready for conductors! They drop easily into place.

3. **CLOSE** . . . and hand-tighten. Roeclamp is completely installed—without removing gloves, and without tools!

About New 15 KV Roeclamps

They're strong—test to 1800 lb breaking strength! Tough Plexiglas* defies weathering, has top electrical properties. Conductors are at 7-inch centers for best electrical protection, easy installation. Roeclamps have unit construction, no separate parts. The big nut can be loosened readily, even with "boxing gloves" on. It hand-tightens. No tools required ever . . . no clamp is easier to install. And you never have to remove the Roeclamps for phase changes or repairs. Roeclamps come complete with grommets to fit the messenger and cables you order. Only 34 Roeclamps are required every 1000 feet.

*Reg. T. M.—Rohm & Haas Company

FREE!

Final Offer

UNIQUE TEXT... OFHC® COPPER

"Technical Survey of OFHC® Brand Copper" is truly a unique contribution to copper literature. Much of the data packed into its 122 pages is unavailable in any other single source-book. More than one hundred tables, charts, graphs, and photographs—*compiled for the first time anywhere*—present original research findings on the physical, electrical, and thermal properties of OFHC and other types of copper.

Conductivity, ductility, tensile and fatigue, creep and rupture of OFHC as compared with other coppers, are among the many topics covered. Chapters include:

- **Nature of OFHC Copper**
- **Physical Characteristics when Unalloyed**
- **Physical Characteristics Dependent on Condition**
- **Effect of Impurities and Alloying Elements**
- **Metallography, Methods of Analysis and Testing**

This is the last public offer of this unique text. So many requests have been received to date that we must conclude the offer with this advertisement.

From the enthusiastic comments we've received, this book is proving invaluable to designers, engineers, and metallurgists throughout the electrical equipment field. As a man in this field, you, too, will want "Technical Survey of OFHC Brand Copper" for your technical library.

To get your free copy, handsomely bound in finest buckram, fill in the attached form and mail it to us. Remember, this is your final opportunity and our limited supply will be distributed on a first-come, first-served basis. So write today!

Product Development Department

AMERICAN METAL CLIMAX, Inc.

61 Broadway, New York 6, New York

AMAX

Yes! I would like to own "Technical Survey of OFHC Brand Copper." I understand that the book is free and there is absolutely no obligation.

NAME.....

POSITION.....

COMPANY.....

ADDRESS.....

.....

(Offer good only as long as supply lasts.)

Industrial Notes...

Rust-Oleum Corp. Evanston, Ill. . .

The comparative rates at which rust proceeds in different parts of the country, have been exactly established for all cities in the United States having 10,000 population. It takes three years, the fastest rate in the country, for rust to corrode a standard, uncoated steel test panel, the size of an auto license plate. Slowest rust rate is more than 15 years. In all the nation's major industrial centers, the rust rate is under 4 years. This was disclosed in the first Rust Index of the United States, published by the Rust-Oleum Corporation, 2799 Oakton St., Evanston, Ill. The Index, result of a 25-year research program, lists the 523 cities of the country with a population of more than 10,000 and the comparative rust rate for each city. Variations in rate result from the different amounts of rainfall, wind, corrosive gases, sunlight, and salt water present in each locality.

Remington Rand New York, N. Y. . .

A better way has been found for man to communicate with the electronic "brains" which have taken over much of his work. The U. S. Air Force's Air Materiel Command, and the Remington Rand Division of Sperry Rand Corporation, 315 Fourth Ave., New York 10, N. Y., have jointly developed a method for using a limited vocabulary of English verbs to instruct business-type computers. The new method, known as the Air Materiel Command Automatic Compiler, (AIMACO) will initially use 30 English verbs, and has flexibility of enlargement to additional verbs as circumstances dictate. In a precise sense, instruction coding is not eliminated by the new English language program, rather, it also has been automated. To replace the laborious task of manual translation from English to machine language, the new system simply uses a large-scale computer to make this conversion electronically, for itself and for other makes and models as well.

Bakelite Co. New York, N. Y. . .

Toroidal reactors, used in electronic equipment in the *B-58* jet aircraft, are now encapsulated in compounds based on Bakelite epoxy resins by Torwico Electronics, Inc., Union, N. J., the maker. This encapsulating material was selected because of its superior thermal conductivity, the manufacturer reports. Heat generated within the reactor windings must be removed so that the insulation will not burn out. The epoxy-resin-based compound provides the necessary conductivity and surpasses the heat conduction demands of the Armed Forces transformer specifications. Dielectric properties of these epoxy resins are high, and provide ample insulation of the encapsulated reactor coils. Almost impervious to moisture, the encapsulating material offers sufficient water resistance to meet any type of atmospheric conditions. Bakelite Co., Division of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

Narda Microwave Corp. Mineola, N. Y. . .

Manufacturers of radar and microwave communication systems often find that it pays to have the more intricate components of their systems designed by a specialist, rather than have their own engineers try to do it themselves. Quicker delivery at lower cost usually results from adopting this procedure. Engineers faced with such problems will welcome the news that The Narda Microwave Corporation, 118-160 Herricks Rd., Mineola, N. Y., specialists in electronic test equipment and components for microwave and uhf systems, is now offering a custom-engineering service to design and produce these types of components, on a prototype as well as quantity production basis.

J. B. Shipp and Associates Lake Charles, La. . .

This firm, located at Room 15, Kaufman Bldg., Lake Charles, La., was recently organized and is chiefly an electrical and mechanical engineering practice.

Westinghouse Electric Corp. Pittsburgh, Pa. . .

Three 250-kva pole-type distribution transformers have been installed for the Kansas City Power & Light Company. Manufactured by Westinghouse Electric Corporation, Box 2278, Pittsburgh, Pa.,

Courtesy Westinghouse

the units extend ratings in the line of distribution transformers from 167 kva, largest pole-type units previously manufactured, and are especially suited for application in areas where bulk power demands are served from the pole top.

(Continued on page 32A)

here's the inside story on Southern States cutouts and boric acid fuse links

While Southern States Distribution Cutouts are designed to function properly with other makes of fuse links, there is a measurable difference in performance when Southern States boric acid links are used—not only in our cutouts, but in other makes, too.

The cutaway view tells the inside story of why Southern States Cutouts and Fuse Links work together to provide the ultimate in fuse protection.

The auxiliary tube of the link is unusually long and sealed to the top ferrule. The fusible element is buried in boric acid powder.

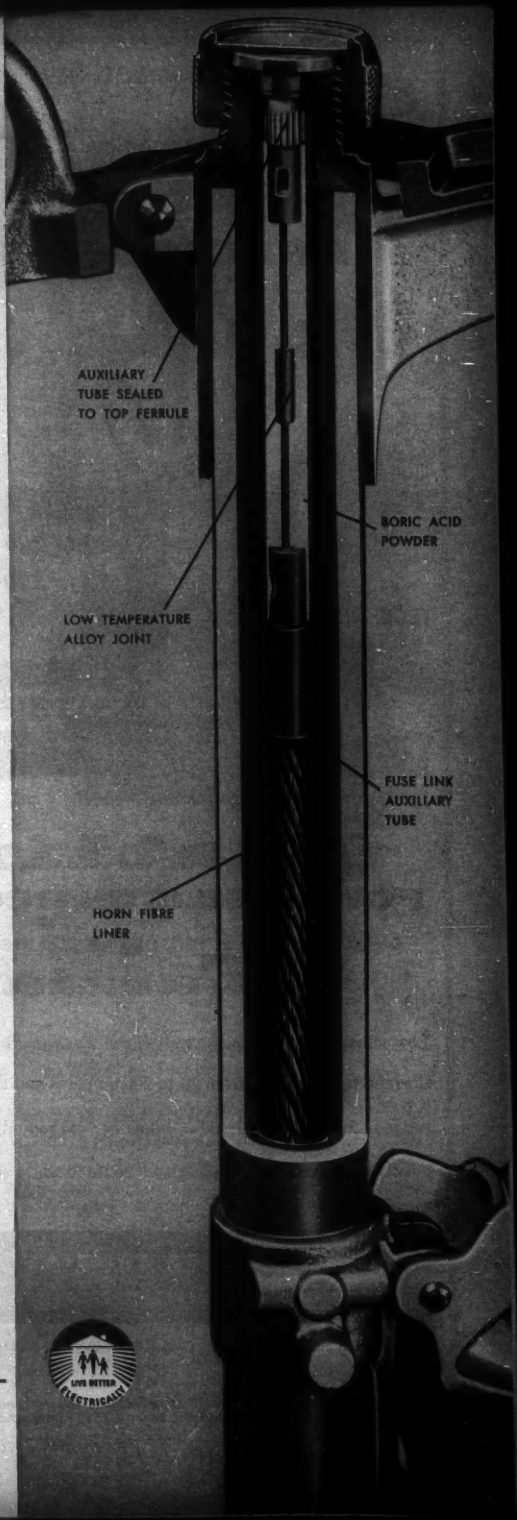
When a fault occurs, even one just sufficient to melt the fusible element, a lot of things happen fast: First, an arc is established when the element separates. The heat generated by the arc instantly converts the boric acid powder into water and then into a large volume of steam. This action performs a dual task. First, vaporization of the water and rapid expansion of gas cools the arc. Simultaneously the arc stream is purged of ionized gas by a fast-moving column of steam.

Circuit interruption is swift and sure.

At higher values of fault current, pressures generated destroy the auxiliary tube. When this happens the same action that occurred in the auxiliary tube takes place in the main fuse tube.

For the ultimate in fuse protection on low or high faults, use Southern States Cutouts and Fuse Links.

Get full information from your Southern States representative, or write for Bulletins 58OC and 55PDL.


AUXILIARY TUBE SEALED TO TOP FERRULE
BORIC ACID POWDER
LOW TEMPERATURE ALLOY JOINT
FUSE LINK AUXILIARY TUBE
HORN FIBRE LINER

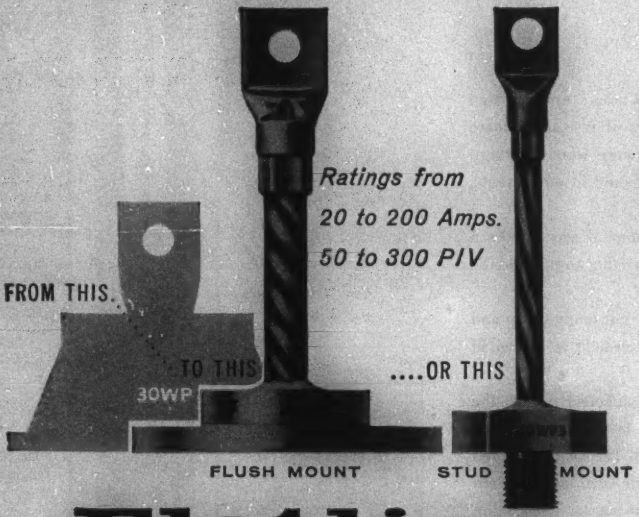
SOUTHERN STATES
EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA Dominion Cutout Co., Ltd., Toronto

LIVE BETTER ELECTRICALLY

Streamlined

TO SAVE PRECIOUS SPACE



Flatline POWER SILICON RECTIFIERS BY Tarzian

Low silhouettes feature the redesigned Tarzian Flatline Silicon Rectifiers. Current ratings range from 20 to 200 amperes and the peak inverse voltage range is from 50 to 300 volts. Flush or stud mounting is optional in either positive or negative base polarity. Write for data sheets.

SARKES TARZIAN, INC.
Rectifier Division

DEPT. E-1, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA

In Canada: 700 Weston Rd., Toronto 9, Tel. Roger 2-7535 • Export: Ad Auriema, Inc., New York City

Industrial Notes

(Continued from page 30A)

Kennecott Copper Corp., N. Y. C. Okonite Co., Passaic, N. J. . .

Kennecott Copper Corporation and The Okonite Company have announced plans to affiliate. A contract has been signed by which Kennecott would acquire through a new subsidiary company the properties, assets, business and good will of Okonite in exchange for shares of Kennecott common stock on a share-for-share basis. Kennecott Copper Corporation, 161 E. 42nd St., New York 17, N. Y., The Okonite Company, Canal St., Passaic, N. J.

Hubbard and Co. Chicago, Ill. . .

Purchase of Electrical Engineers Equipment Company, Melrose Park, Ill., manufacturers of electrical equipment for transmission and distribution lines in the utility and industrial fields has been announced by Hubbard and Company, 200 S. Michigan Ave., Chicago 4, Ill. No change in the organization is contemplated.

General Telephone and Sylvania New York, N. Y. . .

The boards of directors of General Telephone Corporation and Sylvania Electric Products Inc., have voted approval, in principle, of the merger of Sylvania into General Telephone. The details, including the legal steps involved, are being formulated, and when completed, will be submitted to the share owners of both companies. In connection with the proposed merger, the General Telephone Board of Directors also voted to recommend to its share owners a change in the name of that company to General Telephone & Electronics Corporation. The plan under consideration would involve the issuance of one share of General Telephone common stock for each share of Sylvania stock. It is contemplated that D. C. Power, president of General Telephone, will become chairman of the board and chief executive officer of the parent company, and that D. G. Mitchell, chairman and president of Sylvania, will become president. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Sarkes Tarzian, Inc. Bloomington, Ind. . .

According to Convair (Astronautics) Division of General Dynamics Corporation, the Rectifier Division of Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind., was listed as one of 16 Indiana firms having supplied equipment to the Atlas intercontinental ballistic missile program for the U. S. Air Force. Tarzian has participated to the extent of supplying silicon power rectifiers.

(Continued on page 36A)

Industrial Notes

(Continued from page 32A)

Thompson Ramo Wooldridge Inc. Los Angeles, Calif. . .

Effective November 1, 1958, The Ramo-Wooldridge Corporation and Thompson Products, Inc., merged and formed a new company called Thompson Ramo Wooldridge Inc. All of the divisions of the Ramo-Wooldridge Corporation with the exception of Space Technology Laboratories form a single division of the new company called Ramo-Wooldridge a Division of Thompson Ramo Wooldridge Inc. Effective the same date, the Space Technology Laboratories became a separate corporation known as Space Technology Laboratories, Inc. Operations of both groups continue at the same locations: Space Technology Laboratories, Inc., P. O. Box 95001, Los Angeles 45, Calif., and Ramo-Wooldridge a Division of Thompson Ramo Wooldridge Inc., P. O. Box 90534, Airport Station, Los Angeles 45, Calif.

Jones & Laughlin Steel Corp. Pittsburgh, Pa. . .

By using magnet wire packaged in specially designed steel pails instead of on spools, Fasco Industries, Inc., Rochester, N.Y., has cut many thousands of dollars from annual manufacturing costs of field windings for fractional horsepower electric motors in its lines of fans, evaporative coolers, and ventilators. The steel pails contain 10 times longer lengths of wire than can be wound on spools. Because of this, the pail package of wire is replaced only one-tenth as often, and more than 90% of former stator rejects are eliminated. Another important advantage is the elimination of the expensive handling of returnable spools. Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.

Lambda-Pacific Engineering Van Nuys, Calif. . .

A mobile microwave transmitter unit, completely equipped to handle television remote pickups at low cost, is housed in a delivery van type of vehicle, and is operated by as few as two men. It is expected to find wide application among smaller television stations and telephone companies that require economical mobile studio facilities with which to expand their services. The unit takes pictures at distant points, and transmits both audio and video information through a microwave link to the television studio, or to the transmitter for rebroadcast. Quality of signals is reportedly equivalent to that in standard studio operation. The unit is designed for quick, easy setup and takedown, and is supplied complete and ready for operation. Literature will be sent on request. Lambda-Pacific Engineering, Inc., 14725 Arminta St., Van Nuys, Calif.

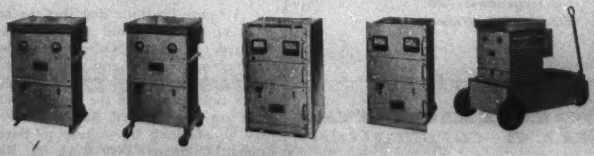
(Continued on page 42)

THERE IS A REASON...why *CHRISTIE* was selected as the principal source of D-C Power Supplies for all the above projects... **RELIABILITY**

CHRISTIE'S rigid Quality Control is approved by the A.E.C. and leading Aircraft and Missile Manufacturers.

CHRISTIE ELECTRIC CORP.
3410 W. 67th St., Los Angeles 43, Calif., Dept. EE

Precisely regulated Power Supplies of permanent stability. Ratings up to 1500 amperes. Bulletin on Standard Militarized units available on request.



CONTINENTAL FOR THE COMPLETE LINE OF INSULATED POWER CABLE

VOLTAGES: 600 TO 15,000
SIZES: 14 AWG TO 2,000,000 CM
INCLUSIVE

With a complete range of voltages and sizes, Continental Wire offers POWER CABLE in types V . . . AIA . . . AVA . . . AVB . . . *SILICONE RUBBER* . . . TEFLON TAPE . . . and VARNISHED GLASS TAPE for extremely high temperatures. For power cable with excellent current carrying capacities, resistance to oil, grease, corrosive vapors, moisture, as well as high temperatures—call CONTINENTAL, Wallingford.

continental wire corporation

WALLINGFORD, CONN. / YORK, PENNA.

Trade Literature . . .

Metal-Clad Switchgear Bulletin . . .

Bulletin *GEA-5664E*, 40 pages, provides detailed information on the operation, characteristics, and application of indoor and outdoor metal-clad switchgear, rated 2.4 to 13.8 kv with interrupting capacities of 75 to 1,000 mva. **General Electric Company, Schenectady 5, N. Y.**

British Business Publications Guide . . .

More than 300 British trade and technical publications, most of them weeklies or monthlies, are described in "Business and Specialized Publications of Great Britain" which is published by members of the Periodical Proprietors Association Ltd. Journals cover such fields as textiles, engineering, shipping, television, aviation, food, finance and management, and many others. The booklet gives the American businessman a chance to learn of the British journals covering his own profession, trade, or hobby. Copies of the booklet can be obtained free from the **British Information Services, 45 Rockefeller Plaza, New York 20, N. Y.**

Aeronautical Company's Facilities Booklet . . .

A 10-page, 2-color brochure describing the capabilities, fields of activity, management, and facilities of Allied Research Associates, Inc. has been issued. The company's work in aerodynamics, applied mechanics, aircraft operations, chemistry, electronics and instrumentation, meteorology, physics research, systems engineering, propulsion, vibration, weapons effects, and weapon systems analysis are presented, along with brief descriptions of the several laboratories. **Allied Research Associates, Inc., 43 Leon St., Boston 15, Mass.**

Eccobond Adhesives Brochure . . .

A 14-page brochure consisting of a series of technical bulletins on a variety of cements, adhesives, and sealments is available. Application information, physical, and electrical property data is presented for each product. **Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.**

Aircraft and Missile Accessories Brochure . . .

A 4-page brochure describes the basic types of air valves and actuators manufactured by Barber-Colman Company. Temperature control and positioning systems, specialized electrical test equipment, and a capsule view of the firm's development are also included. Bulletin *F 5910-1* may be obtained by writing to **Barber-Colman Company, 1400 Rock St., Rockford, Ill.**

Data Processing Tool Brochure . . .

A 38-page brochure describing application information for the Model *ZA-100* computer language translator is now available. **Sales Department, Electronic Engineering Company of California, 1601 E. Chestnut, Santa Ana, Calif.**

Fastener Bulletin . . .

This 4-page, 30th Anniversary products bulletin outlines the broad types of precision-engineered fasteners available with special features, and contains numerous illustrations of unique cold-forged fasteners produced for the automotive, aircraft, appliance, farm equipment, engine, and other industries. Copies of the new bulletin can be obtained from R. W. McPherson, vice-president, sales, **Chandler Products Corporation, 1493 Chardon Rd., Cleveland 17, Ohio.**

Dual Preset Counter-Controller Bulletin . . .

This 4-page bulletin describes the Series *320* instruments designed for coil winding, motor speed control, shearing to length, batching, packaging, and stacking by number, variable pulse interval generation, and process programming. **Computer Measurements Corporation, 5528 Vineland Ave., North Hollywood, Calif.**

Precision Potentiometer Bulletin . . .

A bulletin including specifications, reprints, and other pertinent matter, is available from **Computer Instruments Corporation, 92 Madison Ave., Hempstead, L. I., N. Y.**

Information Processing Brochure . . .

The Intercoupler, explained here, is an electromechanical sensing device which is inserted by means of cables and plugs between an input and an output device; it provides completely automatic operation of the output device with perfect reproduction of information which has been fed to the input device. Applications are accounts payable, payroll, sales distribution and accounts receivable, bill and charge, and material control and inventory control. **Systematics Inc., 60 E. 42nd St., New York 17, N. Y.**

Automatic Transfer Switch Booklet . . .

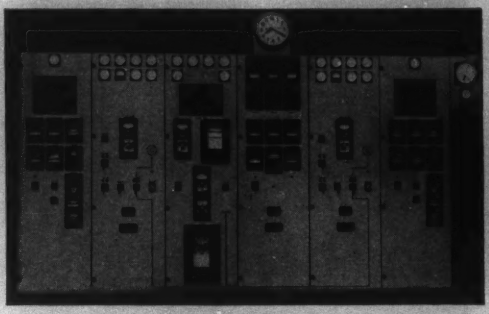
An informative 24-page booklet on the importance and uses of transfer switches has been issued. Illustrated by diagrams, tables, and photographs, the various applications are discussed. **Automatic Switch Co., Hanover Rd., Florham Park, N. J.**

(Continued on page 44A)

In metal-clad switchgear...

Reliability

is born of many men's efforts



Indoor metal-clad power plant switchgear rated 4160 volts, 3 phase, 60 cycles supplied to a partially attended generating station.

It started with a directive—"Make it the best!" A creative team set out to implement this decision. Engineers, designers, production men, and marketing personnel—all took up the challenge. What was *then* good gave direction. They added their talents, their skill, their experience—up-to-date application requirements—designing, testing, redesigning until drawing board plans were translated to market place reality. Out came metal-clad switchgear preeminent in strength, simplicity, and performance. They *had* made it the best!

Type DST air circuit breaker—5 kv, 250 mva, 1200 amps.

From simple feeder circuits to complex generating station protection—when you specify Federal Pacific metal-clad switchgear, you specify reliability. Proof is yours for the asking. Write Federal Pacific Electric Company, Newark, New Jersey for Catalog 3-440—sixty-four pages of the latest in metal-clad switchgear information.

FEDERAL FPE PACIFIC

The Best in Electrical Distribution and Control Equipment

What we mean by INTEGRATED RESEARCH at the G.E. Electronics Laboratory

...and why this concept is so fruitful in valuable findings and individual achievement

Any problem—plucked from the entire field of electronics—that becomes of interest to the Laboratory is studied *simultaneously* from every relevant technical angle, by specialized professional groups. These men maintain direct contact with each other, exchanging information on every phase of a project.

A current instance of this invigorating professional interaction at the Laboratory is a program for developing radically new radar techniques. Design advances—such as an electronically scanned antenna—will be coordinated with the handling of vastly larger amounts of data than radar systems have ever handled before. Scientists and engineers of all seven Laboratory sub-sections are making important contributions to this project.

Significant progress in the program is regularly covered in formal and informal conferences and in technical reports circulated to all groups. Representative report titles listed below indicate how far-reaching are the interacting investigations involved:

Ferrite Materials for Microwave Frequencies *by J. B. Linker and H. C. Rothenberg*

An Electro-Optical Shift Register *by J. A. Baer*

The Performance of an IF Integrator Preceded by a Limiter *by W. G. Hoefer*

Parametric Converters and Amplifiers *by C. S. Kim*

Analysis of Maser Techniques for Infrared Detection *by G. K. Wessel*

Topological Theory of Switching Circuits *by C. Saltzer*

Application of Low Temperature Solid State Amplifiers *by H. H. Grimm*

Laboratory-wide interplay of varied talents is credited by scientists and engineers here with contributing materially to their individual accomplishments. It is also valued as a prime ingredient in the unflagging intellectual appeal the Professional Staff finds in the Laboratory's diverse R & D undertakings.

PROFESSIONAL OPPORTUNITIES AT ELECTRONICS LABORATORY

The Electronics Laboratory engages in applied research and advance development covering the entire field of electronics. More than 70 percent of the Professional Staff have advanced degrees. Openings at various levels exist in the following areas:

Solid State Materials • Magnetics and Dielectrics • Solid State Devices • Network Synthesis • Advanced Circuitry • Electron Solid State Devices • Communication Theory • Recording Devices • Display Techniques • Electron Optics • Radar Techniques • Antennas • Microwave Devices

Write in confidence to: Mr. Robert F. Mason, Dept. 25MA

ELECTRONICS LABORATORY Located at Electronics Park

GENERAL ELECTRIC

Syracuse, New York

Industrial Notes

(Continued from page 36A)

Allis-Chalmers Manufacturing Co. Milwaukee, Wis. . .

A steam surface condenser in which tubes are welded, instead of rolled into the tube sheets, recently went into operation at the Frank M. Tait Station of The Dayton Power and Light Company. This unit, manufactured by Allis-Chalmers, Milwaukee 1, Wis., is a 90,000-square foot, 2-pass condenser that is installed with the Power and Light Company's 150-megawatt steam turbine Unit No. 4.

Motorola Inc. Chicago, Ill. . .

The Pan American World Airway's jet fleet, consisting initially of Boeing *707's* and Douglas *DC-8's*, will be equipped with Motorola Selcal selective signaling equipment. The Selcal decoders will be a recently developed type, featuring fully transistorized circuitry and modular construction. Ground-to-air Selcal systems provide for the in-flight alerting of an aircraft crew to an ensuing radio message. Eliminated are the wearing of earphones and the monitoring of the circuit in the cockpit, thereby significantly reducing pilot fatigue and distraction. Motorola Inc., Communications and Electronics Division, 4501 W. Augusta Blvd., Chicago 51, Ill.

Dalic Metachemical Ltd. Toronto, Ont., Canada . . .

A production technique, developed by Dalic Metachemical Ltd., 121 Judge Rd., Toronto 18, Ont., Canada, allows aneroid elements of barometers, altimeters, depth gauges, and other pressure-sensitive devices to be soldered without flux. By thus

eliminating the chance of leaving corrosive material inside the diaphragm, selective plating reduces rejects, increases service life, and improves the seal and reliability of the product.

Positive Protection Against Phase Failure and Phase Reversal ?

Here is your answer!

The Allen-Bradley Bulletin 812 Type F, Type R, and Type RF relays provide positive protection against the hazards to men, motors, and driven machinery, resulting from phase failure and/or phase reversals.

The Bulletin 812 Style F phase failure relay employs a unique static sensing network that responds to all open phase conditions on a motor branch circuit and immediately removes the motor from the line . . . irrespective of the load on the motor (including no load), or the circuit arrangement. This relay even responds to hard-to-detect primary failures on a wye-delta transformer with ungrounded neutral. Furthermore, the five-cycle response prevents nuisance "drop-outs" from transient fluctuations.

The Bulletin 812 Style R phase reversal relay disconnects the motor from the line—whether it is running or not—when a phase reversal occurs anywhere in the system on the line side of the relay. Thus, it can be employed for a single motor, a group of motors, or an entire power system. In addition, the phase reversal relay prevents the motor from starting should phase failure occur while at a standstill—a vital feature for elevator applications.

The Bulletin 812 Style RF relay combines the elements of Style R and Style F relays for protection against both phase failure and phase reversal. All Bulletin 812 relays are inherently "fail safe." Send for complete information.

Bulletin 812, Style RF for Phase Failure and Phase Reversal

INDIVIDUAL RELAY UNITS AVAILABLE
For Phase Failure
For Phase Reversal
Style F covers full load currents from 1.5 to 300 amp in 4 sizes. Coils for up to 600 v, 60 cycles.
Style R made with coils for 110, 208/220, 440, 550 v for either 50 or 60 cycle operation.

Allen-Bradley Co., 1301 S. First St.
Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd.
Galt, Ont.

A-B

ALLEN-BRADLEY

QUALITY

MOTOR CONTROL

This is one of a series of professionally informative messages on RCA Moorestown and the Ballistic Missile Early Warning System.

BMEWS AND THE PROJECT ENGINEER

Time, money and the achievement of performance specifications are the three dimensions in the world of the Project Engineer. Scheduling, cost control and technical accountability . . . these are grave responsibilities on any engineering program involving the national security. On BMEWS, with its objective of early warning against enemy missile attack, they comprise the most sensitive of engineering assignments, anywhere.

The Project Engineer assigned to BMEWS is a business-scientist who has a proven record of accomplishment in the creative engineering of electronic systems and who has the interest and acumen to view this work with a management posture. He is also a scientist with the significant trust of defining the interfaces of delicate personal and group relationships. This talent must be especially refined in the BMEWS Project Engineer, for BMEWS employs the multiform facilities and personnel of not only RCA Moorestown, the weapon system manager, but also of several other major corporations whose BMEWS effort is coordinated by RCA.

RCA Moorestown invites Project Engineers to investigate the professional opportunities afforded by this and other vital national defense programs currently in progress. Please direct inquiries to Mr. W. J. Henry, Box V-9A.

EQUAL OPPORTUNITY

RCA RADIO CORPORATION of AMERICA
MISSILE AND SURFACE RADAR DEPARTMENT
MOORESTOWN, N. J.

Trade Literature

(Continued from page 38A)

Rating Systems Application Note . . .

This Application Note reviews the significant differences between the three rating systems currently in use by the electron tube industry: the absolute-maximum, design-center, and design-maximum systems. The design-maximum system, which is the newest and latest, is discussed in detail. Request Application Note *AN-174* from **Commercial Engineering, RCA, Harrison, N. J.**

Silicone Rubber Heater Literature . . .

Detailed are construction features of the new heaters, which the manufacturer believes are the answer to a long-felt need for greater application flexibility in the design of electric heating units. They are described as flexible, waterproof, very thin, available in any plane shape, and adaptable to almost any area where heat up to 400 F is needed. Ask for Bulletin *C-102*. **Watlow Electric Manufacturing Company, 1376 Ferguson Ave., St. Louis 14, Mo.**

Electrical Tape Data Booklet . . .

Technical and comparative cost information on the Hesgon line of Fiberglas electrical tapes is now available. This publication points out how Fiberglas tapes offer the manufacturers of electrical equipment a strong, highly flexible, inorganic, high-temperature, moisture and chemical resistant insulating material. Copies of "The Inside Story of the New Hesgon Line of Fiberglas Electrical Tapes" are available through **Horace Linton Division, Hess, Goldsmith & Co., Inc., 1400 Broadway, New York 18, N. Y.**

Epoxy Compound Table . . .

A table of 20 epoxy compounds showing pot life, curing cycles, weight losses and gains, shrinkage, thermal shock, and other special properties and applications has been released as a complement to the company's 6-page folder on insulating and sealing compounds, by the **Biwax Corporation, 3445 Howard St., Skokie, Ill.**

Synchronous Motors and Controls Booklet . . .

A 27-page booklet, "Synchronous Motors and Controls," contains motor selector charts, application data, and formulas for calculating power factor. The booklet presents a quick summary of types and features of motors and controls. The material includes a discussion of power factor correction, factors to consider in selecting the motor, and special application problems. For a copy of Booklet *B-7292*, write **Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.**